RADIO & ELECTRONIC COMPONENTS

Vol. 2 No. 7 Published Monthly July 1961

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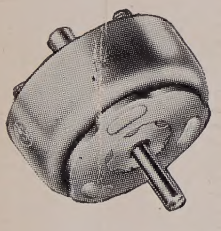

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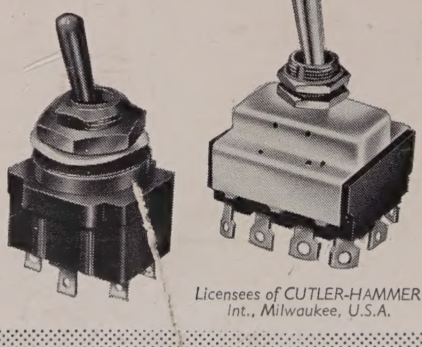

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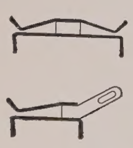

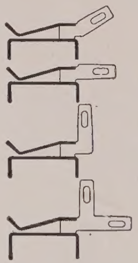

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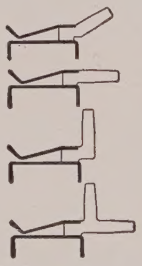

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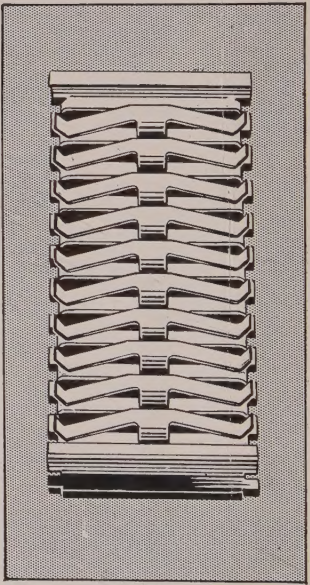

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VOL. 2 NO. 7

JULY 1961

RADIO & ELECTRONIC COMPONENTS

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HG5005	100	80 mA	.8 v @ 100mA	50μA @—50V
HG5006	70	80 mA	.8 v @ 100mA	50μA @—50V
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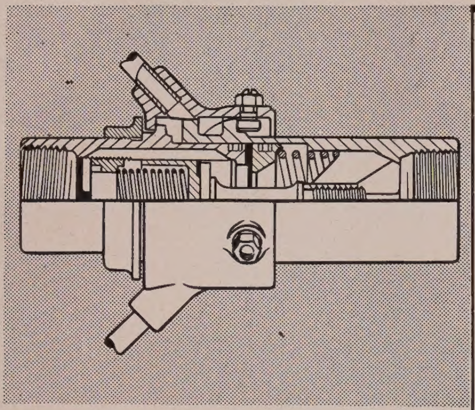

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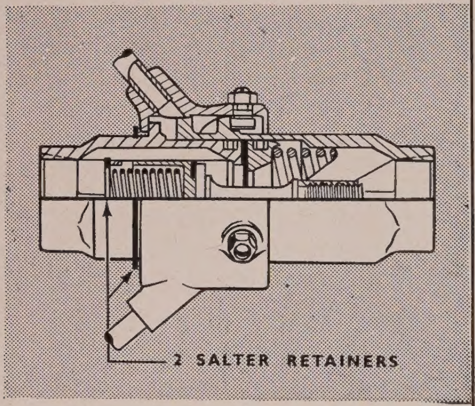

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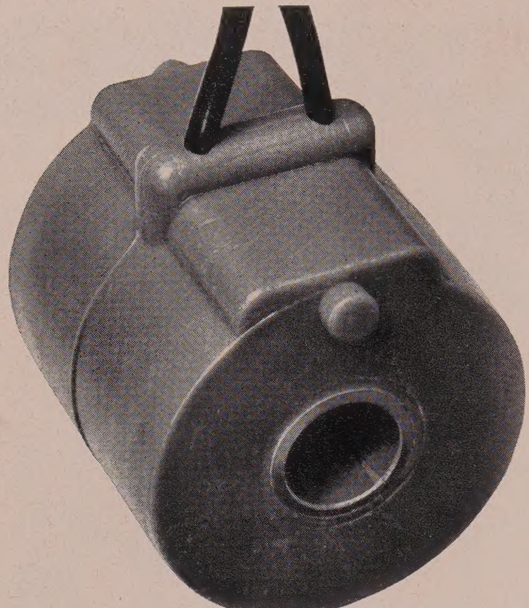

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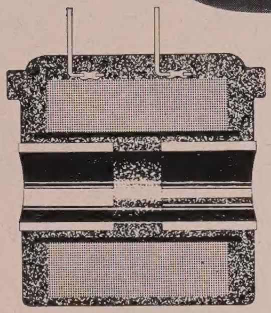

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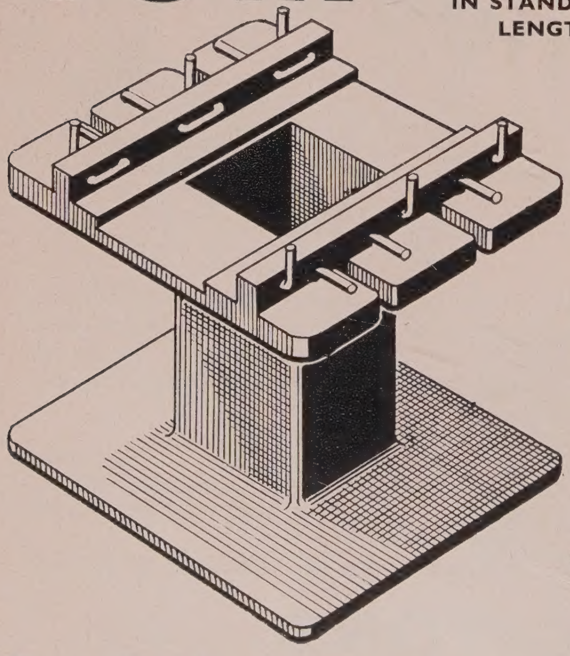

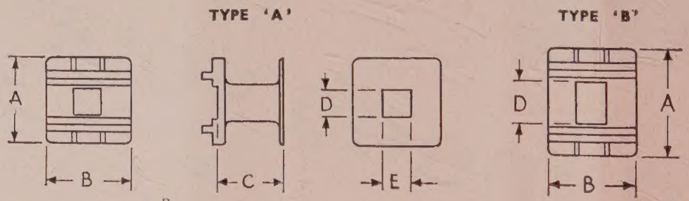

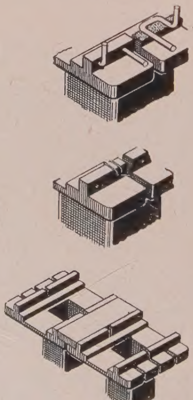

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Code	Type	A	B	C	D	E	L& H	M & EA
267	A	·370″	·370″	·182″	·130″	·130″	267	267
"	B	·510″	"	"	·260″	"	"	"
552	A	·485″	·485″	·244″	·170″	·170″	552	—
"	B	·655″	"	"	·340″	"	"	—
301	A	·550″	·550″	·245″	·195″	·195″	—	301
"	B	·705″	"	"	·420″	"	—	"
216	A	·550″	"	·320″	·195″	"	216	216
"	B	·705″	"	"	·420″	"	"	"
295	A	·550″	"	·370″	·195″	"	295	295
"	B	·705″	"	"	·420″	"	"	"
218	A	·550″	"	·432″	·195″	"	218	218
"	B	·705″	"	"	·420″	"	"	"
187	A	·750″	·740″	·495″	·255″	·255″	187	187
"	B	1·000″	"	"	·510″	"	230 262	262 336

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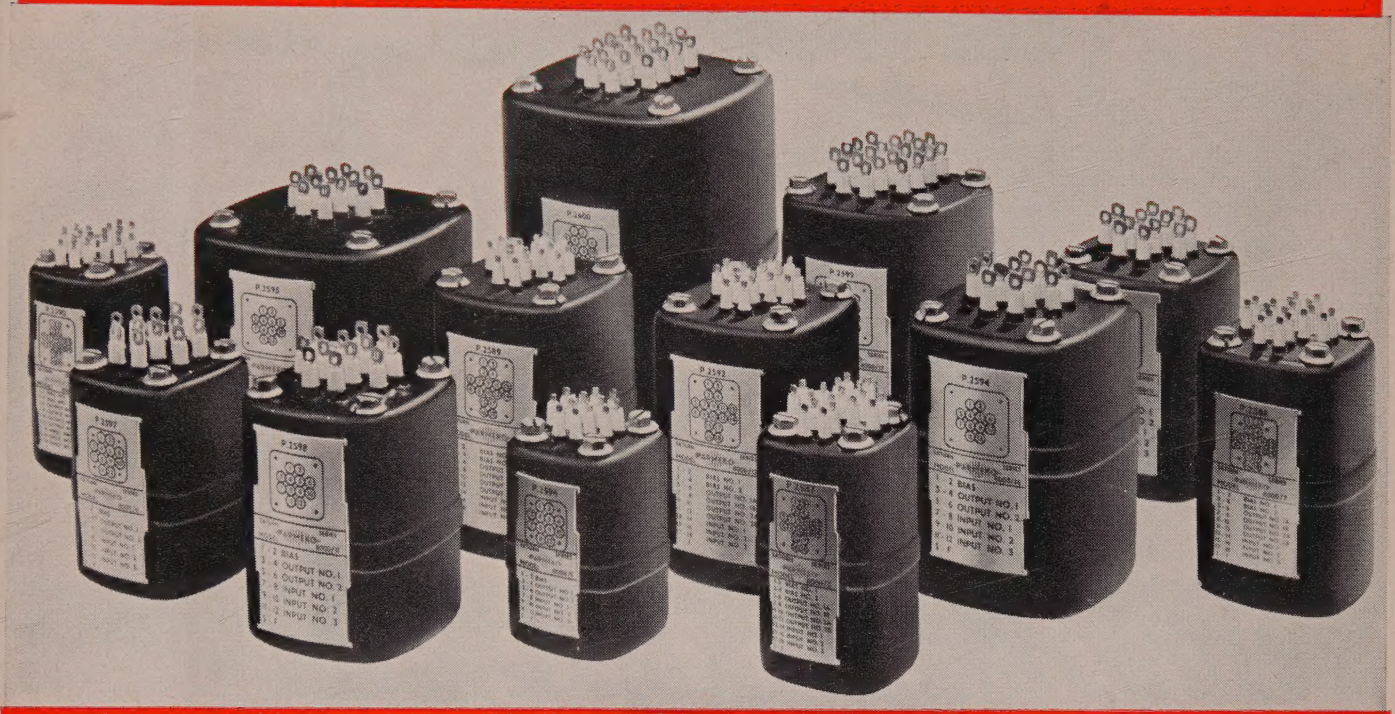

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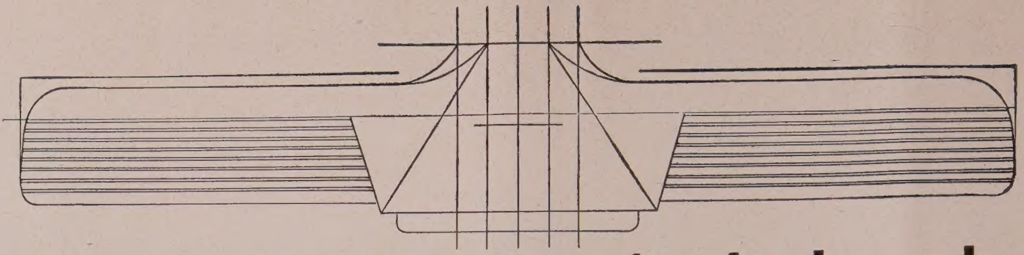

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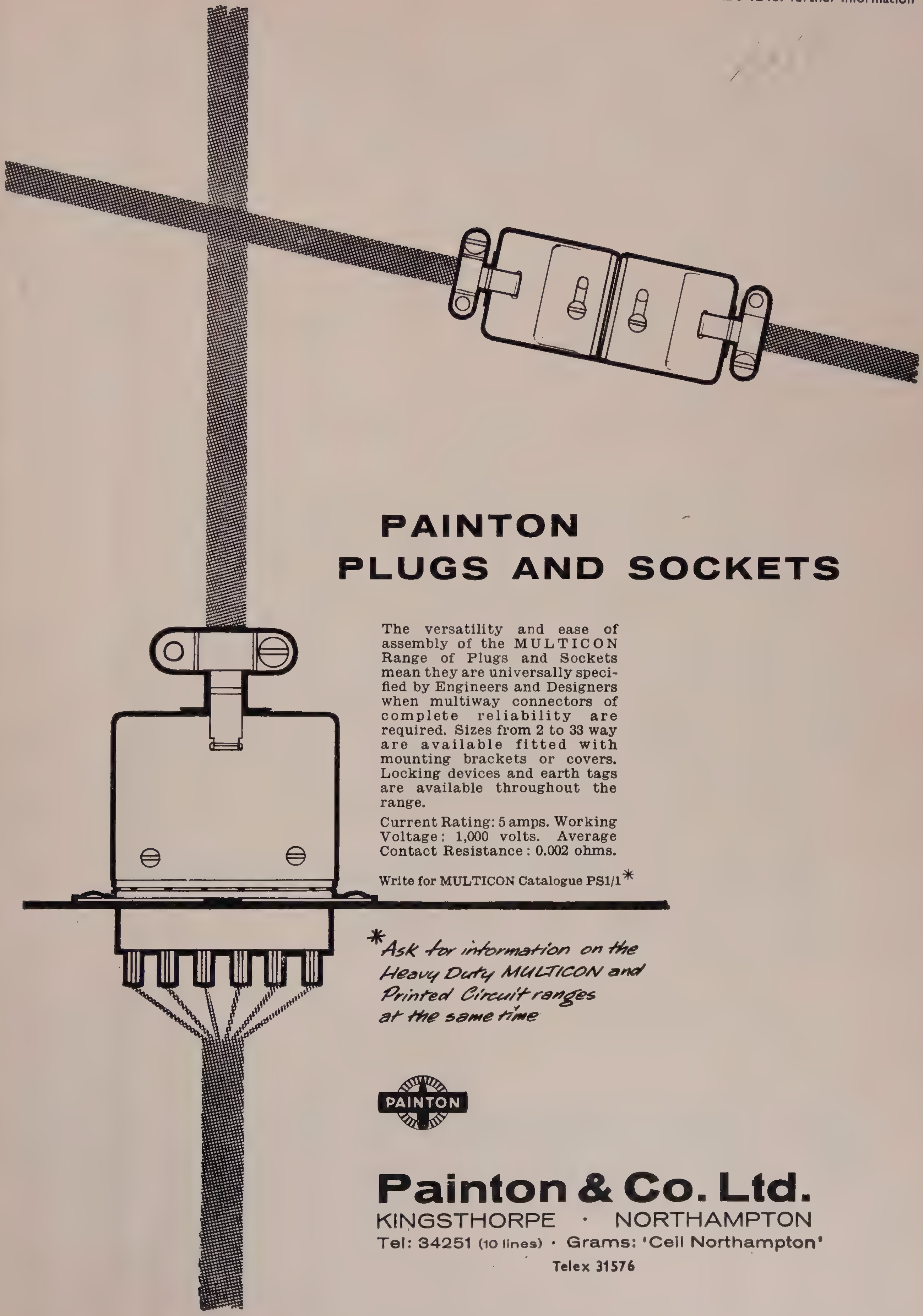

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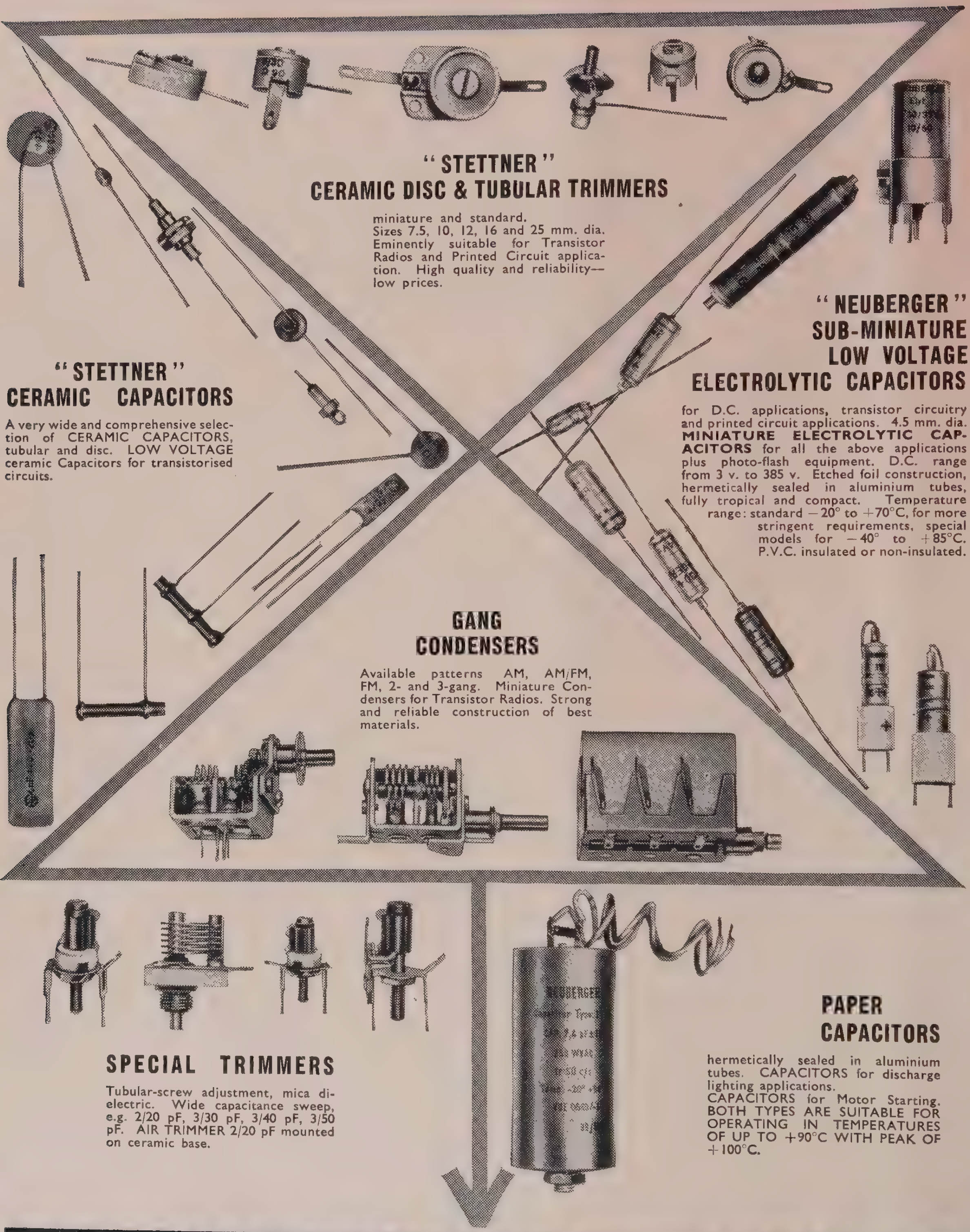

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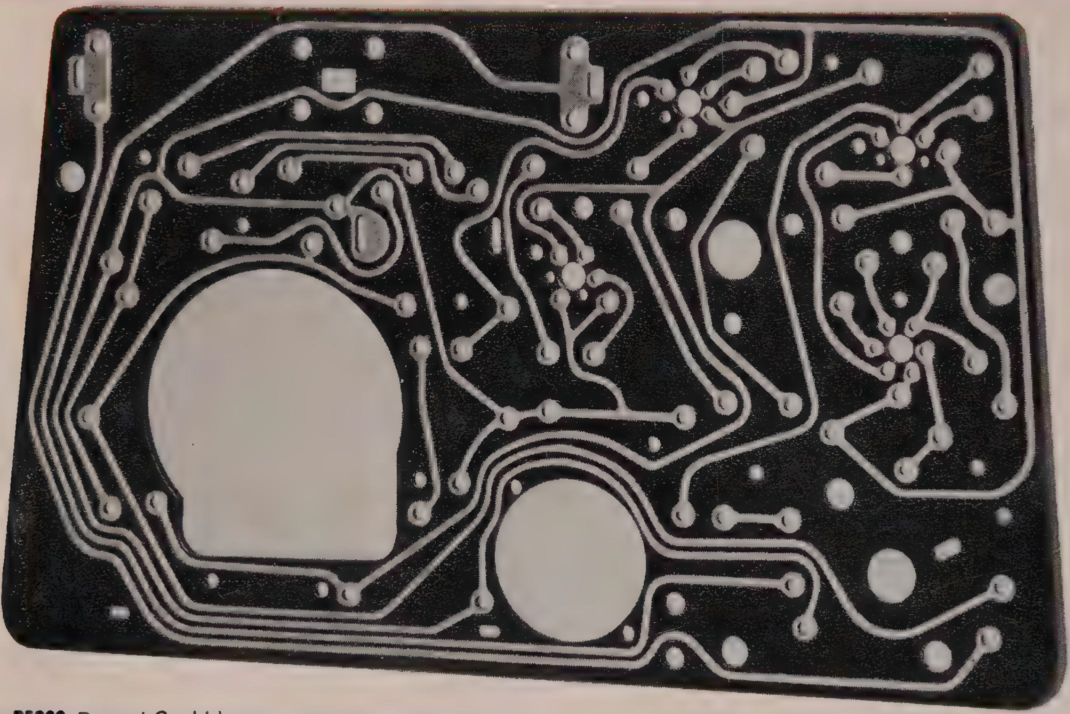

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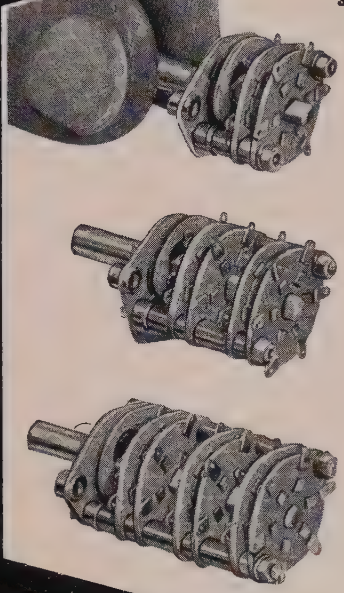

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Initial contact resistance	5 mΩ maximum.
After 10,000 operations	10 mΩ maximum.
Insulation resistance:	
Between contacts Between contacts and spindle	Greater than 5,000 MΩ at 500v DC.
Contact rating	50 mA at 300v DC or AC. 500 mA at 30v DC or AC.
Capacity between contacts or contacts and spindle	0.5 pF approx.
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Turning torque	5 to 20 oz.ins., 360 to 1440 g.cms.
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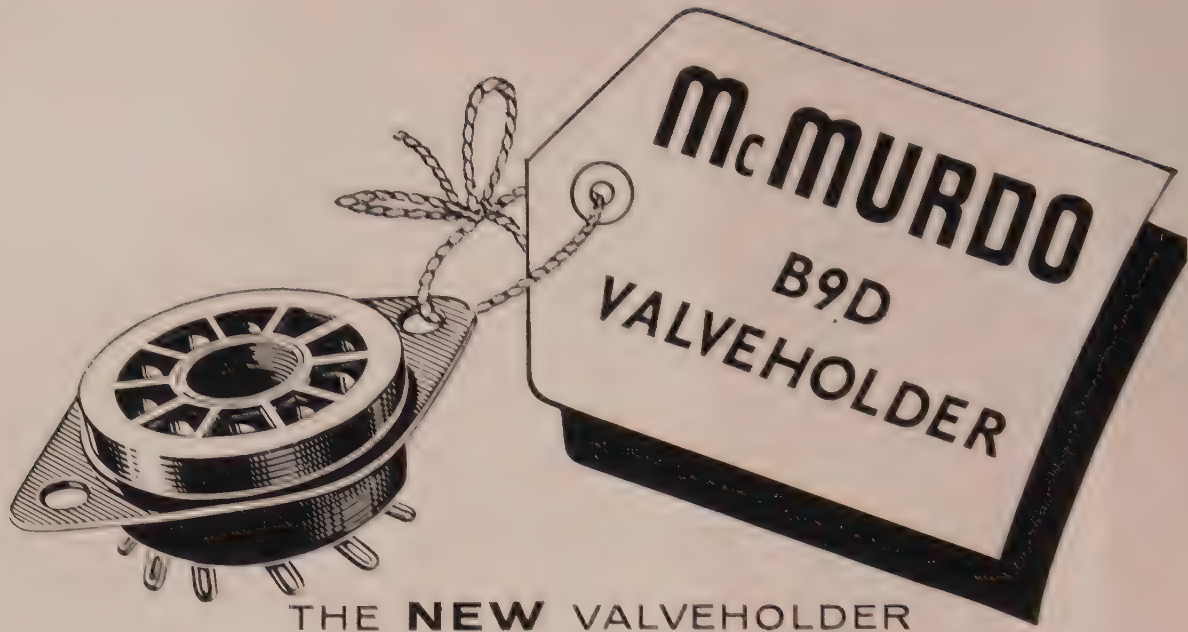

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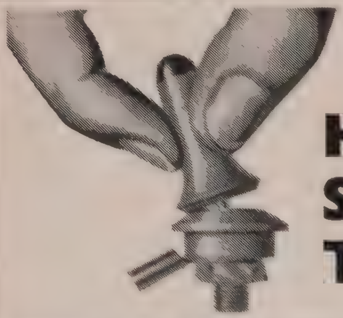

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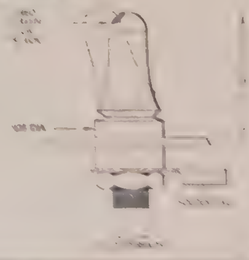

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7·5 MV. Output @ 1 Kc.	Inductance ·8Mh @ 60 Kc.
Fully Modulated Tape	—70 db @ 1 Kc. with 1 VA.

TYPE "B" ½ track ERASE HEAD

Specially designed for battery operated equipment and incorporating a secondary winding giving 90V output to provide A.C.Bias, for our standard ½-track R/P Head at the same time will provide a supply for neon tuning indicator. Used in conjunction with oscillator coil will provide A.C. erasure from a D.C. source, consumption being ·2VA @ 50Kc untuned ·15VA tuned.

STANDARD ¼ TRACK FOUR TRACK

Stereo or Monaural operation

R P	Erase
Gap ·000125	Single Gap
·55 Impedance @ 1 Kc.	Impedance 300 ohms @ 50 Kc.
3 MV Output @ 1 Kc.	—70db with ·6 1·0 VA
0 to +6db @ 10 Kc.	
Fully Modulated Tape.	

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EGEN have made possible aerial isolation in one compact, robust component! Look at these features:

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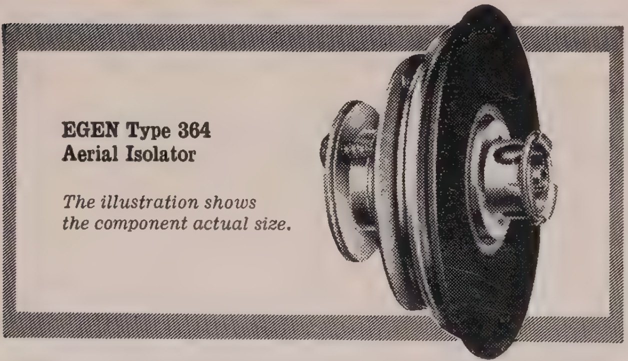

EGEN Type 364 Aerial Isolator

The illustration shows the component actual size.

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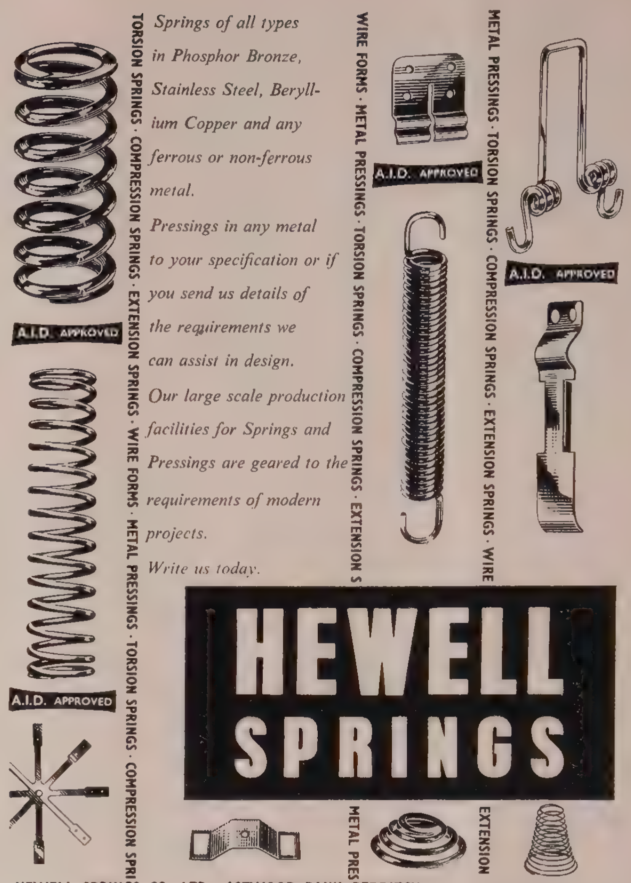
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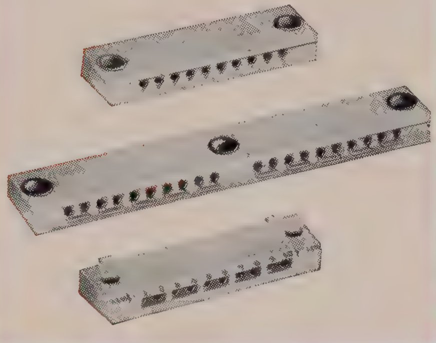

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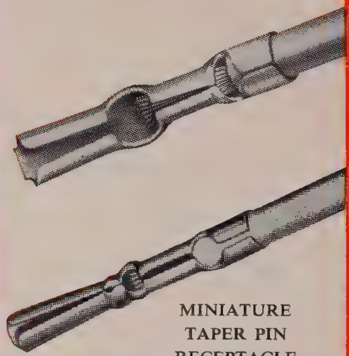

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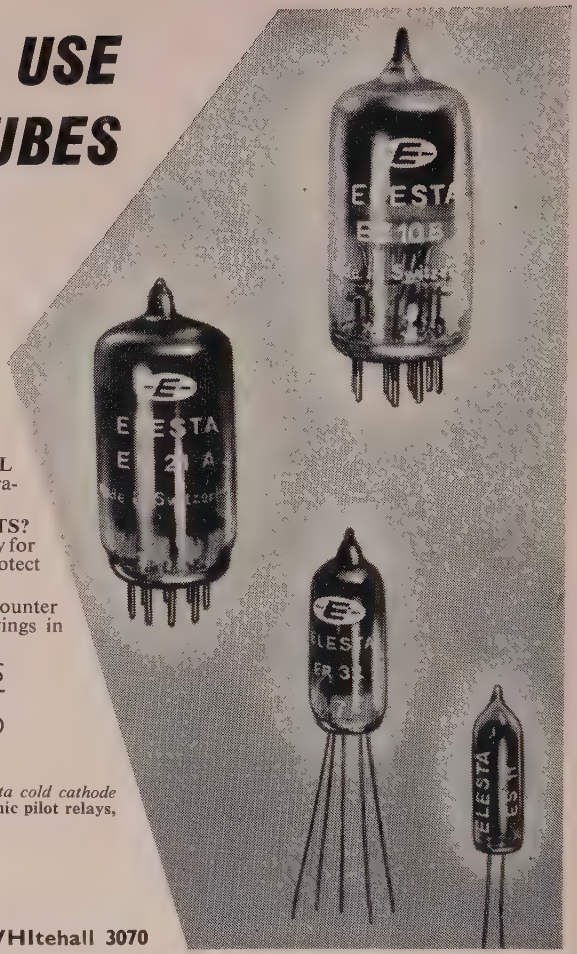

RADIO AND ELECTRONIC COMPONENTS: Vol. 5

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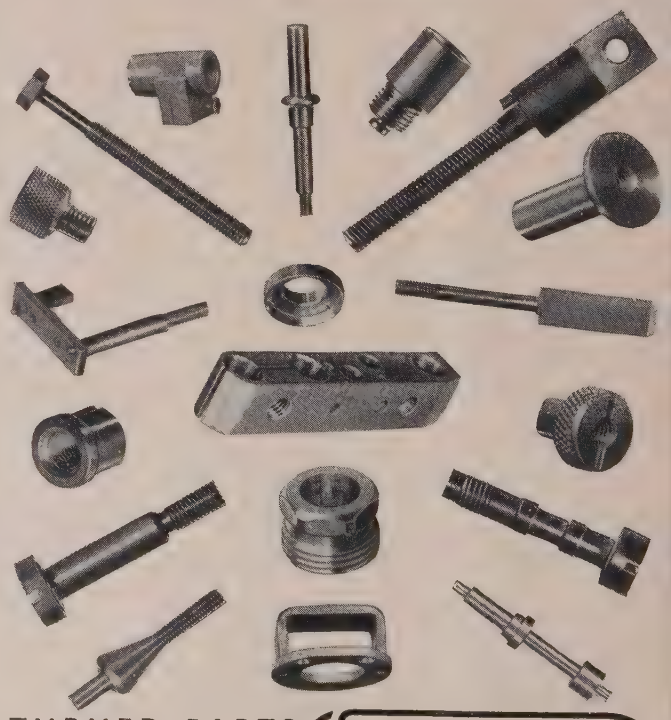

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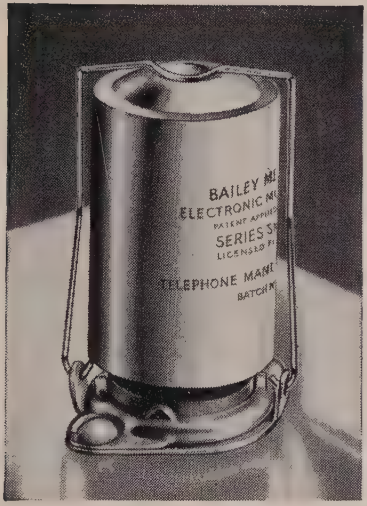
This is news!

now...a transistorized chopper



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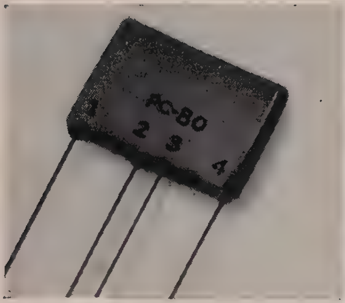

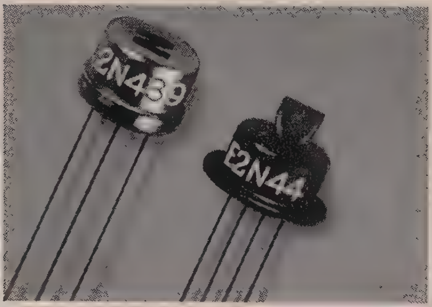

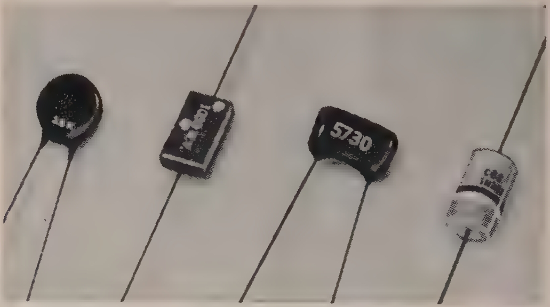

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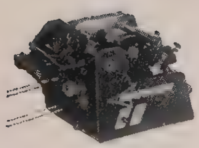
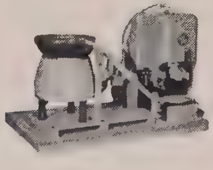


Model 146A — Marking Axial Lead Components with complete legends, including polarity band. Prints neatly on curved, uneven or irregular surfaces. Can be adjusted quickly to different sizes of components. Production speed up to 3000 per hour.



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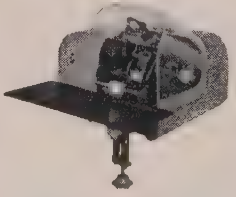

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Write for this 12-page catalog of Markem machines and related equipment for the electrical and electronics industries. Complete specification sheets are also available for individual machines.

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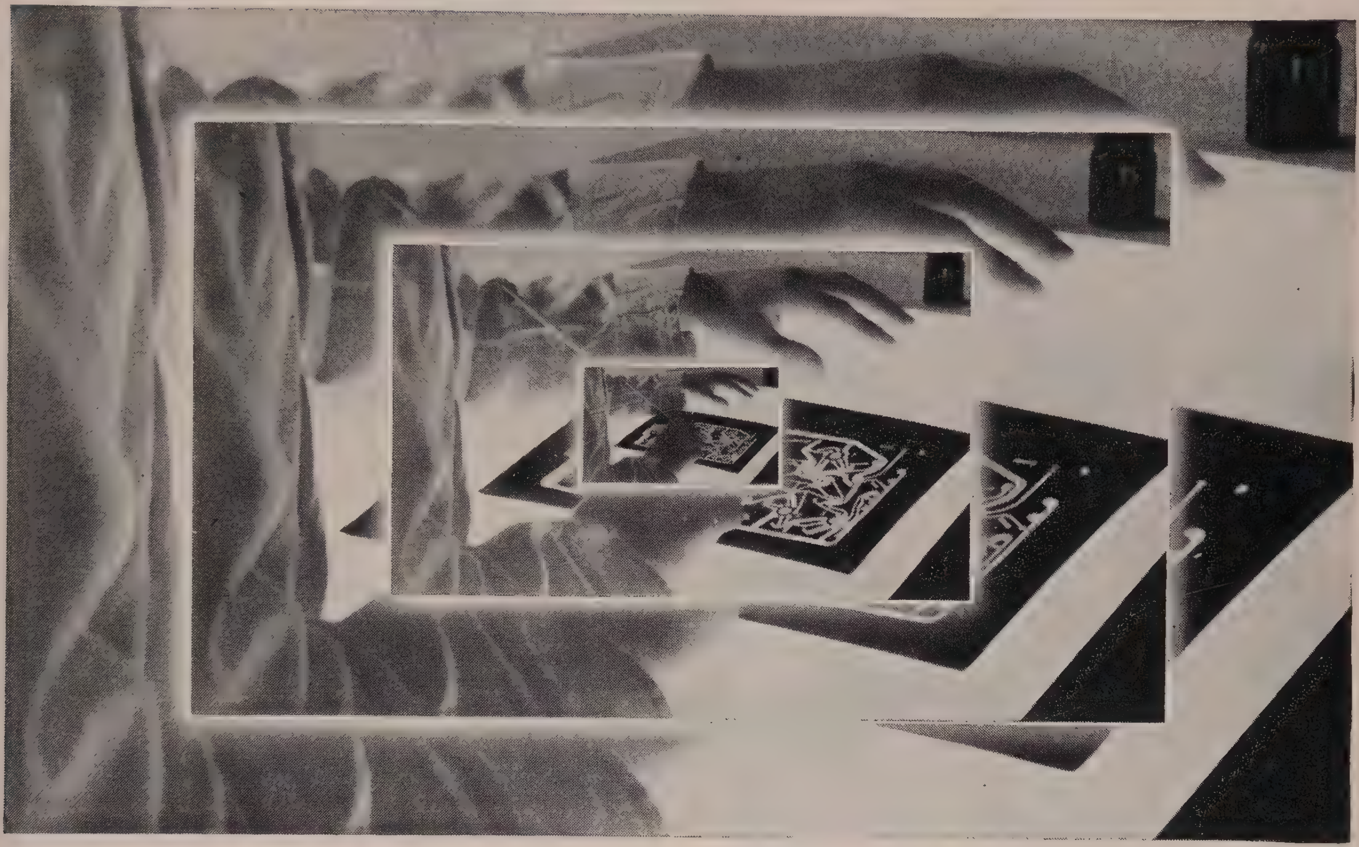

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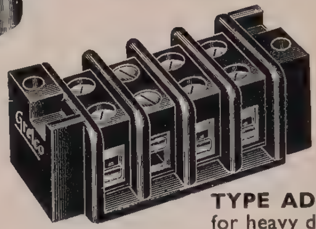

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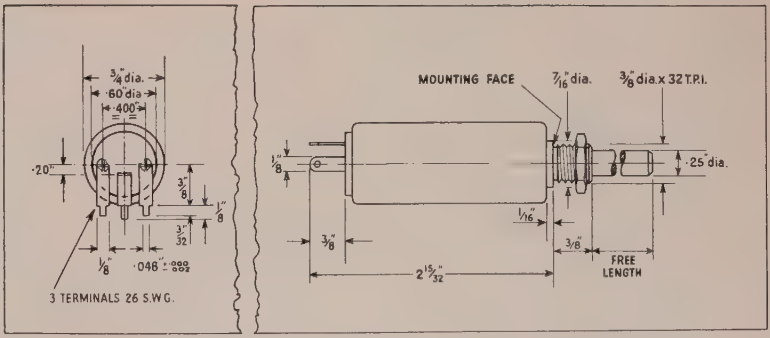

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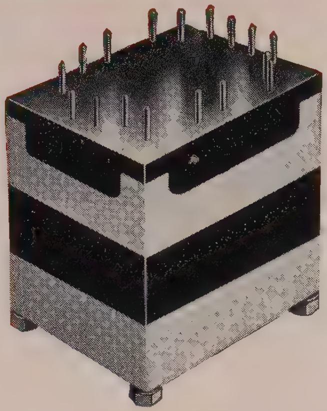

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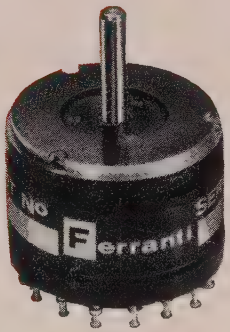

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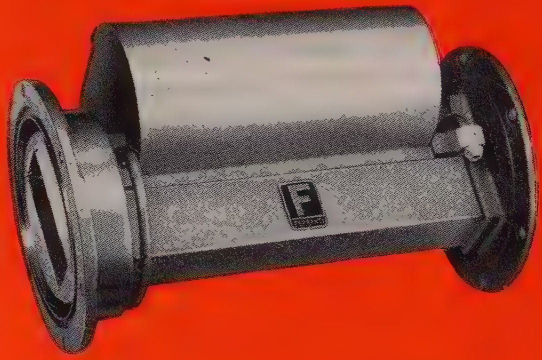

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RADIO & ELECTRONIC
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Commentary

Free Enterprise

IN this competitive world there is a constant thirst for knowledge and a bitter struggle for survival. Never has this been more apparent than in the present day.

For those engaged in industry and commerce there is a morbid fascination in reading the almost daily reports concerning "mergers", "take-overs", "amalgamations" and the stories about well-known companies in difficulties.

Such events are a distinct malady of our time—whatever well-chosen words the "people in the city" might have to say about such things. It is too easy to put the blame on bad management, bad workmanship, industrial strife or other trite terms which seems to suit the occasion. The fact is that modern trading conditions are demanding large sales, research and manufacturing resources to meet competition and many smaller firms have not the facilities to provide these.

This applies particularly to the electronics and allied fields. A small or medium-sized firm may find itself in the position of either joining a large organization or going out of business. This may seem like private enterprise gone mad and a severe indictment of present-day industrial policy—but is this, in fact, so?

To see all such problems in their true perspective it is necessary to place them in a picture showing the world as a whole.

The electronics industry in Great Britain is faced with tremendous competition in world markets yet it has to export to survive. America spends millions of dollars each year on its space programme and by far the greater part of the sum is directed towards research. All industry in the United States benefits, either directly or indirectly, from such research and American products thus have an immediate advantage over comparable British goods. Quality, alone, is not sufficient when such rapid advances are being made. In the electronic components field the United States is considerably ahead in research on semiconductor devices, packaged assemblies and miniature and micro-miniature components. This is a good sales bargaining point even if their production methods do not always match their technological "know-how".

We have now, in the British Isles, a number of American sponsored companies with reasonably free access to the results of research in the United States by their parent organization. Such companies provide considerable competition within our own shores for British concerns.

Constantly one sees advertisements in the press for development, design and research personnel. There are not enough engineers and scientists to satisfy this demand nor is the demand likely to be met in the foreseeable future.

Is it not a fact that a reasonable percentage of the personnel will be required for similar problems in a number of concerns resulting in wasted effort? If companies working on similar projects could get together and pool ideas, research facilities, etc., and assist each other wherever possible, this would not only relieve the demand for technical people but would certainly reduce the wasted effort to which reference has already been made. This would mean sacrificing the outmoded notions of preserving company secrets and ideas from competitors. In the long-term view, it is not now simply a question of the survival of single firms but one of the survival of British industry as a whole. There is certainly no room for the kind of squabbling we now have, for instance, in the television field over which particular line system should be used by British manufacturers.

Ideally, a central committee or organization to discuss the most profitable ways to make the best use of available research facilities would be the most satisfactory method of doing this but, in the short-term view, if only a few more manufacturers were to get together on common problems then we are sure that the rest would, in time, follow. Then, and only then would British industry really begin to catch up with its strongest competitors in the markets of the world.

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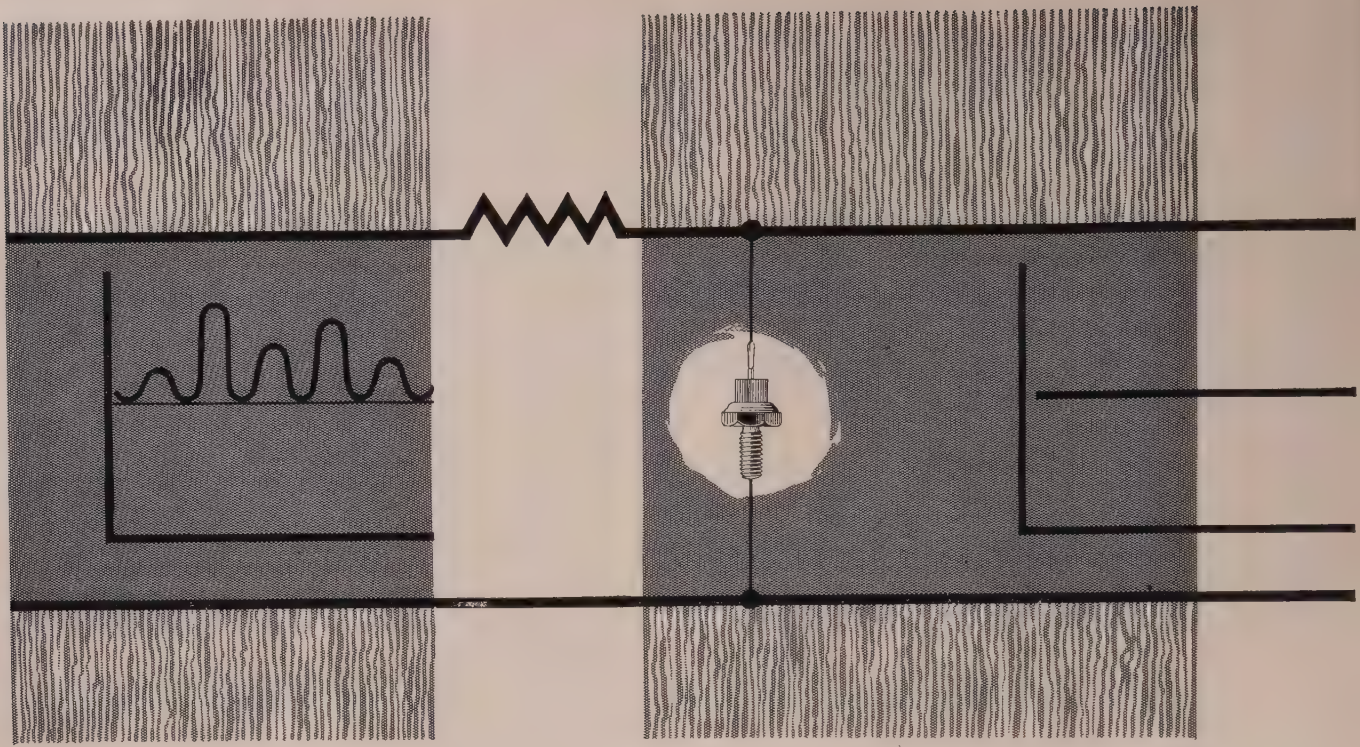

....only LUCAS silicon voltage regulators have all these features

Available in anode to stud, cathode to stud, or double anode versions. Single anode devices may also be used as low voltage rectifiers, having normal rectifier forward characteristics. High power-handling capacity.

Available in higher voltage ranges—up to 100 volts (single anode devices only). Good delivery. Competitive prices. Sales Engineers covering the country and an Applications Team available to advise on all customers' problems.

Type ★	Nominal Zener Voltage	Power Dissipation Watts
ZD 508 CD 58	8.2	10
ZD 510 CD510	10	10
ZD 512 CD 512	12	10
ZD 518 CD 518	18	10
ZD 522 CD 522	22	10
ZD 527 CD 527	27	10
ZD 533 CD 533	33	10

★ ZD Indicates Zener
CD indicates Clipper

The Lucas range of Silicon voltage regulators, covers the voltage range between 8.2 and 33 volts. The regulators are available either as Zener Diodes for D.C. voltage regulation, or as Clipper Diodes for A.C. amplitude control.

FEATURES

- ★ Hermetically sealed
- ★ Operating ambient temperature, —55C to +150C
- ★ Zener voltage tolerance ±10%
- ★ Stud mounted
- ★ Small physical size

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General view of the Exhibition.
(*Photograph by E. J. Millen*)

1961 BRITISH RADIO AND ELECTRONIC COMPONENT SHOW

A REVIEW

By John Borwick

THE seventeenth Radio and Electronic Component Manufacturers' Federation Exhibition moved for the first time from its Grosvenor House venue to Olympia. This gave a five-fold increase in space and easily made this the largest components show ever held in Europe. The extra space pleased all the 250 exhibitors, and meant improved conditions for the many thousands of visitors, including more than 2,500 overseas buyers from 56 countries.

As the R.E.C.M.F. President, Mr. Arthur F. Bulgin, M.B.E., M.Brit.I.R.E., emphasized in his opening address, "We are opening this Exhibition, aimed very largely at the Export Market, at a moment when we are in the most prominent position overseas. Last year, with exports standing at more than 13½ million, 36½% above the 1959 figure, we broke all records for production and overseas sales".

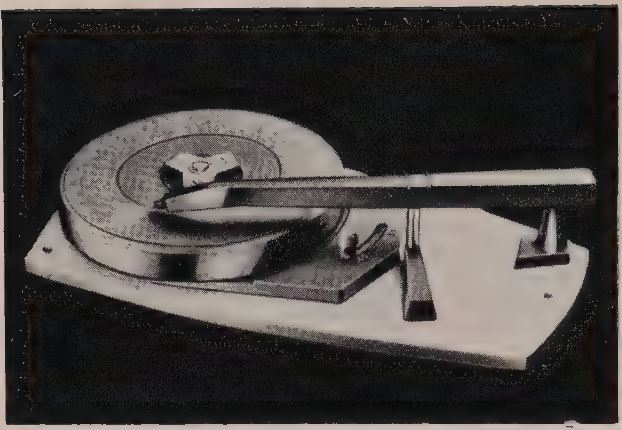
But alongside this impressive expansion in turnover, there are almost unbelievable advances in components technique, and, most important, reliability. The stimuli for these are the many complex electronic applications—computers, colour television, space vehicles, etc. Obviously, the more electronics are used, the more reliable they must be—and, if possible, more components must be capable of being packed into a given space and weight. This was evidenced in the wide use made of two new phrases—"component density" and "reliability testing". A density of 250,000 components to the cubic foot is now possible—indeed **Ardente Acoustic Laboratories Ltd.** exhibited an amplifier with 300 parts to the cubic inch. This kind of advance means components smaller than a match head, often encapsulated into circuit modules to eliminate external wiring and give complete operating stability.

Typical of the heightened interest in reliability were the **Mullard Ltd.** life tests of transistors. Ten thousand transistors are continually under test, representing 40 million operating hours a year with the results read off on a computer. Just as the wartime researches were reflected in a subsequent acceleration in "domestic" equipment design, industrial electronics and missile development are now having an effect on radio and television sets for the "men in the street". The quality of programmes transmitted is better, he can get a better picture or sound with much less fiddling, and his set lasts much longer.

The report which follows makes no attempt to be exhaustive. This would be quite impossible—**A. F. Bulgin & Co. Ltd.,** for example, alone produce some 10,000 different types, and **The Plessey Co. Ltd.,** with the largest stand at the Exhibition and exhibiting a fantastic range of components, might almost require a report on its own. Instead, it briefly details some of the new and well-presented components, for the benefit of readers who were unable to tour this mammoth, attractively staged event for themselves.

Audio Equipment

A number of gramophone turntable units were being given their first showing, and two of these were directed at the battery portable record player market. The "Cygnet" (**Goldring Manufacturing Co. (G.B.) Ltd.**), has



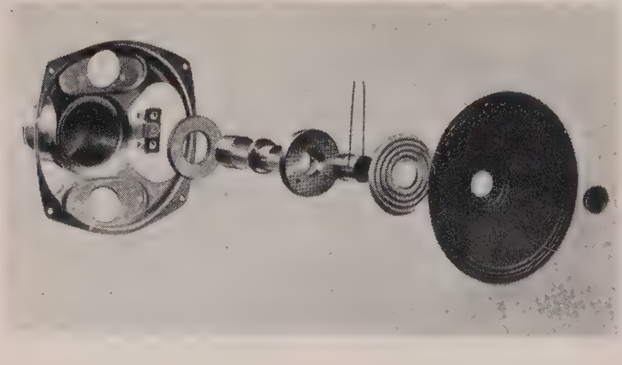
(*Greencoat Industries Ltd.*)
2-speed battery operated record player for 12, 10 or 7 in. records and for either 6 V or 9 V operation.

four speeds, 16, 33⅓, 45 and 78 r.p.m., is powered by a 6-pole low-current motor and includes auto-stop. **Greencoat Industries Ltd.,** showed a range of 3-pole and 6-pole Kinder d.c. motors and the "Little Staar" turntable operating at 33⅓ and 45 r.p.m. from either 6 V or 9 V batteries. Just added to the **Garrard Engineering and Manufacturing Co. Ltd.'s** extensive range of turntables is the "Autoslim". This weighs only 6 lb. and has a depth of 6 in. including the record changing arm. Simplified construction and the elimination of all unnecessary parts will help further to enable manufacturers to reduce cabinet size. **Collaro Ltd.,** also showed a brand new record changer, the A-700.

Possibly the biggest news in the audio transducer field was the **Brush Crystal Co. Ltd.'s** announcement of PZT Multimorph ceramic piezo-electric elements. These are preferable to Rochelle salt in tropical conditions and are virtually unaffected by temperature. They are constructed as a single plate, instead of the usual bimorph sandwich, and have twice the compliance of barium titanate elements. It is expected that PZT Multimorphs will be used widely in gramophone pick-ups, microphones, pen recorder actuators and shopper systems.

Small-size loudspeakers are increasingly in demand, and all manufacturers had at least one miniature on show. Typical of these was the 2¼ in. unit shown by **Fane Acoustics Ltd.** In addition to the conventional cone Model 220, an inverted cone version, Model 210, was shown. This is for mounting in a bezel on the outside of sub-miniature radios so that the only inside space required is that of the magnet cup. **Goodmans Industries Ltd.,** introduced speakers in five diameters from 2 to 3 in. and exhibited their range of vibration generators. The latter give maximum thrust forces from 2 lb. to 18,000 lb. and permit *in situ* testing of structures as diversified as valve electrodes and complete aircraft wings.

(*The Plessey Co. Ltd.*)
Exploded view of typical Plessey loudspeaker with boltless construction.



Lustraphone Ltd., showed the prototype of a miniature contact microphone, the CMC/68 "Contadyne". This is a noise-cancelling moving-coil instrument useful in detecting or recording small vibrations in industrial or medical applications.

Capacitors

The lower working voltage and smaller size requirement of transistors has greatly influenced capacitor development, and changes have taken place in variable, electrolytic, and other fixed capacitors.

Electrolytic capacitors consisting of two tantalum foils wound together with a spacing tissue were featured by **Standard Telephones and Cables Ltd.** The dielectric is a pentoxide layer formed electrochemically on the anode foil, and has very high stability. The non-corrosive electrolyte is impregnated in the spacing tissue and completely sealed. Sub-miniature tantalum electrolytic capacitors were shown by the Component Division of **Mullard Ltd.** The smallest can measured only 0·08 in. ×0·2 in. and contained, for example, a 0·64 mF capacitor at 25 V working, or 1·6 mF at 10 V working.

The "Castanet" electrolytics of the Chemical and Metallurgical Division of **The Plessey Co. Ltd.,** have an entirely different construction. Here the anode is a porous pellet made by sintering tantallum powder under carefully controlled conditions. Sulphuric acid is used as the cathode or electrolyte, and is sealed in a silver container. An operating temperature range of −60° to 200°C is achieved with the standard Type A unit. This measures 22 mm diam. by 6 mm deep, giving a basic capacitance of 50 mF at 70 V working. Since the dielectric film thickness is proportional to the formation voltage, the same size of anode can be processed to give a range of increasing capacitance at reduced working voltages, the highest C being 750 mF at 3 V d.c. Another feature is the very low leakage current which allows, for example, time constants of over 1 hour to be obtained with a simple r.c. network. An even newer Plessey development is a range of miniature plastic electrolytic capacitors designed specially for transistor applications, and assembled on ¼ in. pins for vertical printed-circuit mounting.

Fixed polystyrene type capacitors were shown by a number of exhibitors, including several new developments. The poly-carbonate capacitors of **Suflex Ltd.,** for example, are designed for conditions of extremely high temperature and will work continuously at a temperature of 125°C. A particularly wide range of polystyrene tubular capacitors was shown by the **London Electrical Manufacturing Co. Ltd.**—10 pF to 30,000 pF, 20, 125 and 350 V at d.c. working.

A solid dielectric variable capacitor, introduced by Mullard Ltd., represents an old idea brought up to date. It is designed for pocket radios, and has two sections 0—180 pF and 0—80 pF for aerial tuning and local oscillator tuning respectively. Each section incorporates an 0—6 pF trimmer; rotor and stator vanes are brass, and the dielectric is low-loss plastic. The dust-proof cover measures only 0·787 in. square by 0·59 in. deep, and has projecting terminal pins for direct soldering into a printed circuit. In direct contrast was the high-vacuum variable capacitor shown by **English Electric Valve Co. Ltd.** Using a vacuum as dielectric allows the plate spacing to be reduced by a factor of 10 : 1, the resulting compactness effectively minimising strong capacitance and inductance.

Instruments and Techniques

Measuring instruments are vital in all stages of the design and manufacture of components and each new technique calls for modified test procedures and meters. Testing audio amplifiers and components, for example, will be assisted by a new "tone burst" generator Type TG.11 introduced by the Electronics Division of **Thorn Electrical Industries Ltd.** This gives easily reproducible short period bursts of sine waves over a frequency range from 10 c/s to 10 Kc/s with repetition rates from 1 to 1,000 per second and duration of burst variable from 1 ms to 1 s. The same group's Ferguson WH.11 generator operates on 405, 525 or 625 line standard, when driven by a standard sync-pulse generator. It produces an electronic graticule or dot pattern for accurately assessing the linearity of television scan systems, and is fully transistorized.

A fully transistorized oscilloscope was demonstrated by **Microcell Electronics.** Known as the Type 400, this has a Y amplifier bandwidth of d.c. to 10 Mc/s, and the time base range is 10 μs to 3 s plus an "expand" facility. Maximum use has been made of printed circuitry to improve accessibility and portability. The built-in silver/zinc battery power pack gives 8 hours continuous running, and a charging unit is included for connecting to the mains supply.

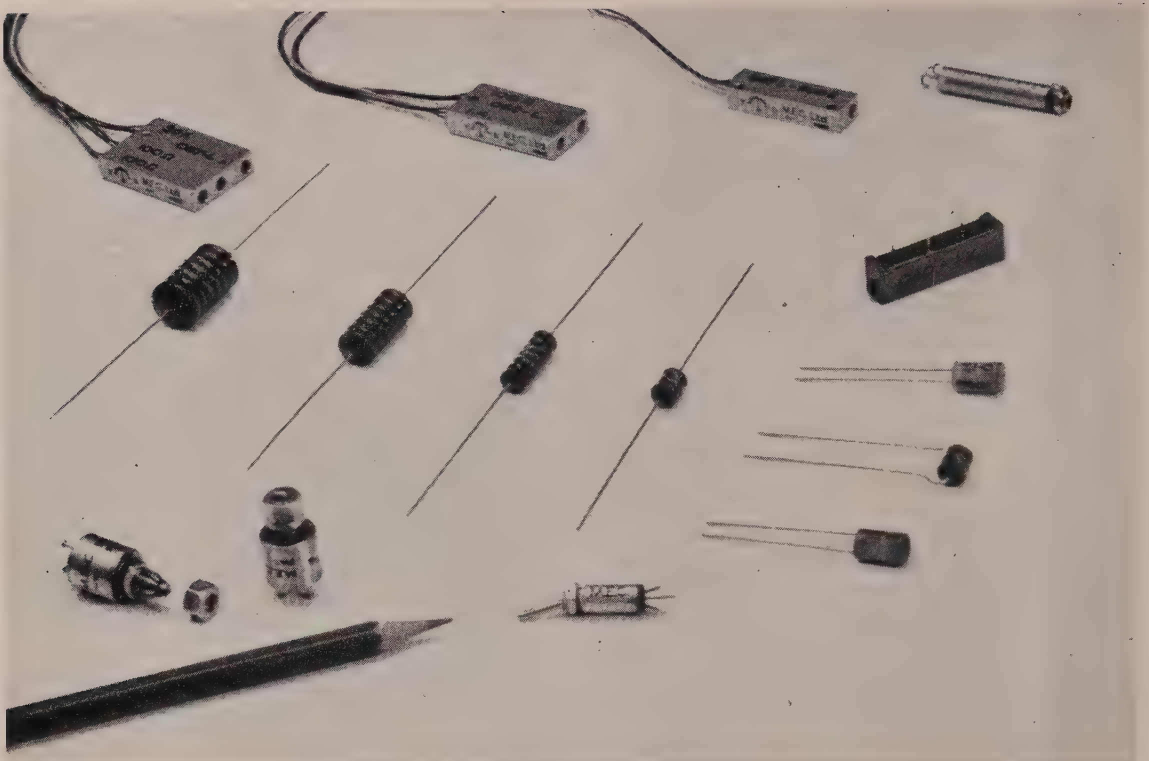
The Type TF 1370 wide-range Wien-bridge oscillator was amongst a number of new exhibits by **Marconi Instruments Ltd.** It covers 10 c/s to 10 Mc/s in six decade bands, the topmost of which, 1—10 Mc/s, is wide enough to assist greatly in the testing of video and lower h.f. bands. The total overall scale length is 105 in., so that a 1% change in frequency is easily discernible. Also shown was the Type TF 1371 wide-band millivoltmeter. This is accurate over a frequency range 30 c/s to 30 Mc/s and so can be used for measurements of signal levels through h.f. receivers from aerial to loudspeaker. An ingenious sequence of coloured lights and an illuminated "P.O. Telegram Form" introduced a range of new dial set, automatic reset timers at the **Electrical Remote Control Co. Ltd.'s** Stand. The telegram emphasized the Company's ability to meet early delivery dates when required.

(*Marconi Instruments Ltd.*)
Wide-band millivoltmeter Type TF 1371.

The high-speed testing and calibrating of resistors, capacitors and inductors prior to using them in mass-production lines is accelerated by a new component comparator and automator developed by **British Physical Laboratories.** This permits testing speeds up to 6,000 components per hour, with a bridge frequency of 100 Kc/s or 50 c/s. It compares the component under test with a standard unit and directly indicates the percentage deviation, with tolerances down to 0·1%. A full description of the equipment is given in a series of articles appearing in this *Journal*—the first of which was published in May.

Closed-circuit television has numerous applications in the component industry and elsewhere, where visual supervision of one or more locations is required from remote points. The cost of such an installation can be reduced considerably using a new **Beulah Electronics** television camera which feeds into the aerial socket of ordinary television receivers—up to 20 of them simultaneously. The camera costs 225 guineas, employs a 1 in. Vidicon tube, and measures 12×7×6 in., excluding lens.

Full automation of the assembly of glass diodes was demonstrated by the **Bader Machinery Co. Ltd.,** designers of lamp and semiconductor machinery. The system has 18 assembly units, delivers a completed diode every 2 s, and is acknowledged to be the most comprehensive in the world. Also aimed at rapid and economic



(*Miniature Electronic Components Ltd.*)
Part of a wide range of miniature components exhibited.

construction—of industrial control systems, computers, etc.—are the **Mullard Equipment Ltd.'s** electronic building bricks. These are widely used, as the 20 examples of manufacturers' equipment constructed from them confirmed, and comprise four ranges—Combi-Elements, Norbits, power supply sub-assemblies and counters. Each building brick is a complete, fully-developed and tested circuit. By using them, an electronics manufacturer can construct his own control systems etc., without the need for time-absorbing circuit studies or proving exercises.

Aircraft-Marine Products (G.B.) Ltd., have developed the technique of solderless wiring to special terminals and contacts, and their newest exhibit was an automatic crimping machine which secures wires to terminals without the need for stripping off the insulation. By integrating special tags with printed-circuit boards, **Amphenol-Borg Ltd.,** showed how solder dipping can be obviated. In a typical assembly line this has reduced a 7½ hour sequence to 40 min.

Materials

Glass mouldings find application widely throughout the electronics industry, and **The English Glass Co. Ltd.,** staged a most impressive exhibit of indicator lamp and moulded instrument covers, lenses, filters, glass/metal bondings, etc. They also showed the "Econyfill" inert filler. This has a specific weight of 2·5 and is suitable for the encapsulation of small components or as a filter in epoxy resins. **Midland Silicones Ltd.** demonstrated the varied applications of silicones, i.e., polymeric materials based on chains of alternate silicone and oxygen atoms. Besides the silicone-glass laminates used in coil formers, printed boards etc., we were shown "Cold-Cure Silastomer", the silicone rubber used in encapsulation, potting and sealing, silicone lubricants, sleeving, resistor coatings, mouldings and extrusions.

Plastics, too, were much in evidence, including the **Formica Ltd.'s** range of paper-based, fabric-based and glass-based industrial laminates, and the products of **Imperial Chemical Industries Ltd.** (Plastic Division). The latter include "Perspex" acylin sheet, "Diakon" acrylic moulding powder, "Fluon" (p.t.f.e.) and "Melinex" polyester film. The roles of these and other I.C.I. plastics were identified in a centre-piece consisting of a cutaway model of a t.v./v.h.f. receiver.

Though conventional steel and alloy magnets continue to meet many requirements, the barium ferrite ceramic magnets are in increasing use. **Swift Levick & Sons Ltd.,** exhibited a range of these—the Feroba 1 permanent magnets. These have the appearance of black pottery, are brittle, light, non-conducting, and rustproof. A special feature is the high coercivity, making for a high resistance to demagnetization effects from stray fields, etc. In powder form, barium ferrite may be embodied in plastic or rubber to form flexible magnets for door-seals, conveyor belts, displays, gloves, masks, etc. Swift Levick also showed a rubber strip variant, and "Eclipse" magnetic plastic sheet and strip was exhibited by **James Neill and Co. (Sheffield) Ltd.** This was incorporated in Eclipse picture shift magnets and pincushion corrector magnets for use with 110° television tubes.

A diversified range of specialized solders is now made to suit specific production techniques. Indeed **Multicore Solders Ltd.** have 400 specifications, including the Ersin Multicore Savbit Alloy which gives a tenfold increase in soldering bit life. Automatic soldering is much favoured in computer and component assemblies, creating a demand for preformed rings, washers, pellets, etc. Typical of these requirements is the solder pre-form for power transistors, giving efficient conduction cooling into the heat sink panel. **H. J. Enthoven and Sons Ltd.** demonstrated a soldering machine for preforms, and carried a display of their pre-form range—1½ million of which were used in the Echo 1 Satellite.

Printed Circuits

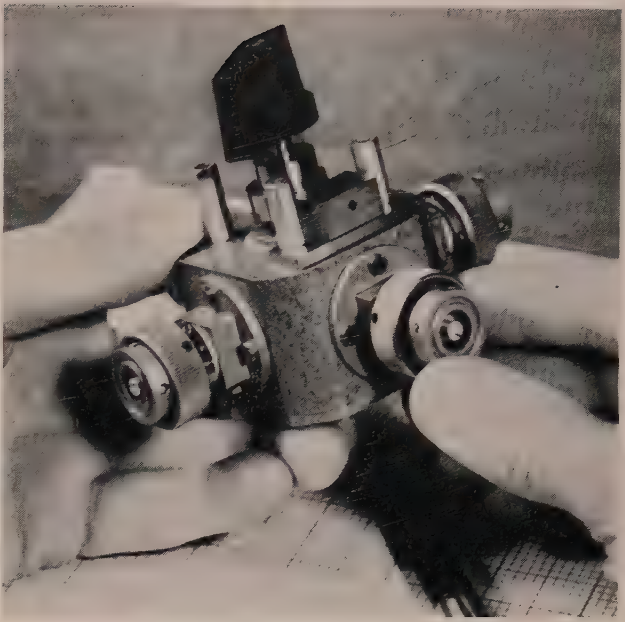
(Pressac Ltd.)
A view of the display devoted to die-stamped circuits and a wide range of components.

In addition to the circuit boards familiar in radio sets, etc., **Printed Circuits Ltd.** showed "Plasmet" copper etched printed armatures for small electric motors, and panels for computers, timers and counters. The printed circuits of **Pressac Ltd.** are made by a different process (see *Radio & Electronic Components*, March, 1961). This employs a heated metal-cutting die to delineate the conductor pattern on one or both sides of the base material. It is best used in mass-production applications, of 5,000 boards or more, when a 25% to 40% economy is possible. Once the die is produced, the circuit configuration is maintained indefinitely, and the base material is unaffected since no chemical solutions are used.

The **Plessey Components Group** exhibited an interesting range of printed switches. These give a normal life of 100,000continuous revolutions at elevated temperatures, and include tapped inductances for u.h.f. circuits and switched crystal holders as well as multibank switches of smaller dimension and greater dependability than conventional rotary types.

Relays and Switches

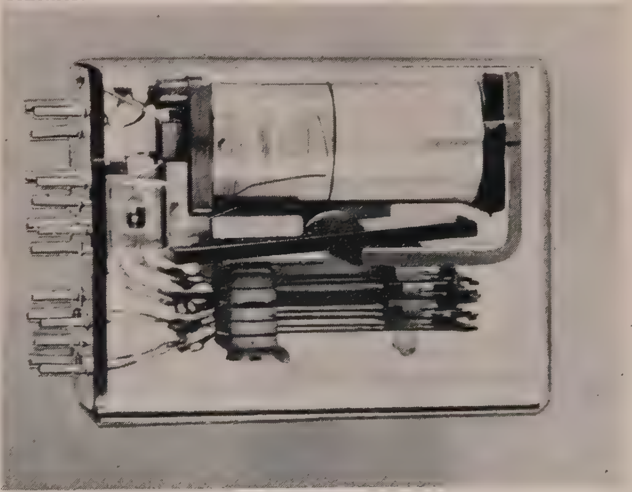
Miniaturization was, again, evident in the field of relays and switches. **Fortiphone Ltd.** have developed their Type G.100 relay for the Ministry of Aviation for use in guided weapons, and it measures only 0·8×0·9×0·37 in. (2-pole changeover) or 0·8×0·9×0·7 in. (4-pole changeover). Gold alloy contacts are used, and the coils and contacts are sealed in separate compartments to eliminate contact contamination.

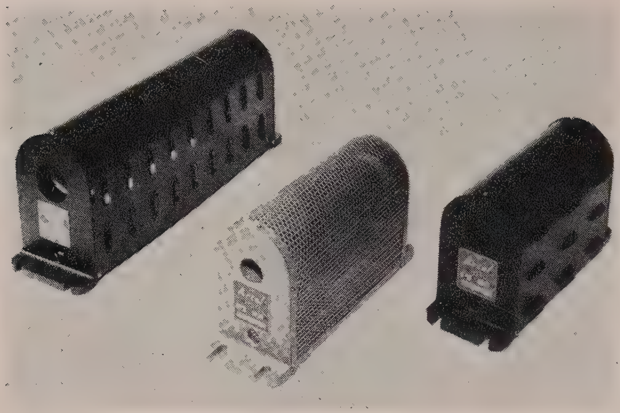


(Marconi's Wireless Telegraph Co. Ltd.)
Type F1206 50 ohm coaxial switch.

The Relay Division of the **Telephone Manufacturing Co. Ltd.** created a great deal of interest by showing the new transistorized chopper, SM 10. It is fully encapsulated, will operate from any 6 V sinusoidal or square-wave supply from 40 c/s to 1,000 c/s, and switch a range of chopping voltages from 1 μV to 250 mV. The changeover is practically instantaneous, resulting in a 50% "on" and 50% "off" duty cycle. The dimensions of the aluminium container which fits a B9A valve socket, are $1\frac{11}{16} \times \frac{15}{16}$ in. diam.

(The Plessey Co. Ltd.)
The Type CB plug-in relay for use in printed or conventional wiring schemes.





(*Ashburton Resistance Co. Ltd.*)
Three examples from the HD range of resistors.

Many manufacturers were exhibiting smaller versions of switches already in their catalogues. Typical of these were **Electronic Components** who introduced a 16-way stud-type switch of about half the diameter of the previous model. **Arrow Electric Switches Ltd.,** introduced a new series of slow make-and-break rotary switches with 3, 4, 5 or 6 positions, and suitable for 15 A 250 V a.c. only.

To prove the reliability of today's switch components—since switches were at one time suspect as potential points of failure—two exhibitors ran life-test demonstrations for the duration of the Exhibition. **Henry and Thomas Ltd.'s** switches were undergoing continuous open-and-close operations at a rate which would give a total of 1,000,000 switchings by the end of the Show. A metering system checked that no significant change in the contact resistance took place. **"Diamond H" Switches Ltd.,** who also exhibited hermetically sealed and general purpose relays, had a switch life-test with a rate of 10 operations per second.

Special control-type switches giving alternative operations by manipulation of a "joy-stick" lever are required on installations as varied as television cameras and diesel trains, and switches of this type were featured by **Pye Switch Division.** In addition to simple sequence control switches, these components include potentiometers as required.

Resistors and Potentiometers

The humble resistor with tolerances of 5%, 10% or thereabouts has now been joined by numerous specialized types of high stability, high temperature consistency and tolerances as low as 0·01%. Choosing the right resistor for the job is therefore of first importance, particularly where the resistor performance is critical as in voltage dividers, d.c. amplifiers, multivibrators, etc.

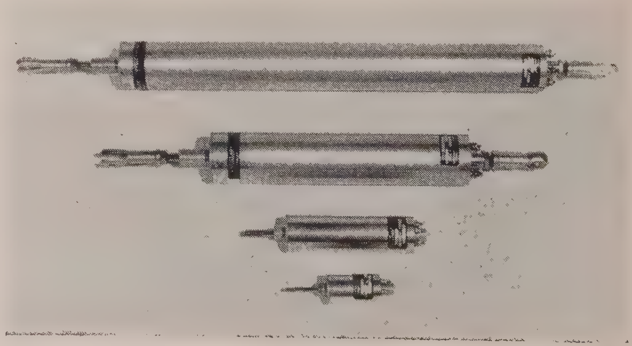
Rivlin Instruments Ltd. have developed an improved method of epoxy resin encapsulation giving high stability against humidity. This was effectively demonstrated on a bridge assembly which immersed a resistor in boiling water, withdrew it and showed the rapid return to the correct value. A special addition to their range of 0·01% resistance standards for laboratory use was a five dial Wheatstone bridge giving an overall accuracy of 0·005%. **James A. Jobling** demonstrated the high durability of the metal oxide film on their "Electrosil" resistors. The metal oxide film is fused at red heat to an alkali-free glass rod, and has exceptional ruggedness. The demonstration consisted of a steel blade, motor-driven to scrape the film continuously while a meter indicated the unchanged value of resistance. A wide range of accurate "Precistors" was shown by **Electrothermal Engineering Ltd.,** to which they have added a series of sub-miniature types. A new colour coding system—red, green, yellow and blue for tolerances of ±1, 0·5, 0·25 and 0·1 respectively—was introduced by the **Ashburton Resistance Co. Ltd.,** who also disclosed two new Arcol precision wirewound resistors.

Potentiometers were shown in many configurations. The rectilinear units of **Ancillary Developments Ltd.,** for example, have stroke lengths varying from 13 in. down to 1 in. They have high accuracy over a wide temperature range and require a low operating force. **P. X. Fox Ltd.,** had an attractive display in Perspex sheet of helical potentiometers. The standard 3- and 10-turns models have been augmented by a series of miniature $\frac{7}{8}$ in. diam. types with 5- or 10-turns. Multiturn potentiometers of the "trimmer" variety, were shown by **Miniature Electronic Components Ltd.,** and are available with a slipping clutch as an alternative to positive end stops.

Transformers and Inductors

A considerable reduction in size at increased power ratings results from the new method of encapsulating small transformers in resin announced by **Gresham Transformers Ltd.** The first of a new series of "Submin" transformers and chokes were shown by **Ferranti Ltd.,** a special feature of whose exhibits was the large number of working models to demonstrate transistor and other circuit techniques. The coil/cores are encased in epoxy resin so as to withstand the high mechanical stresses associated with military applications, and the pins are of soft brass so that they may be bent over without fracture during assembly to printed cards.

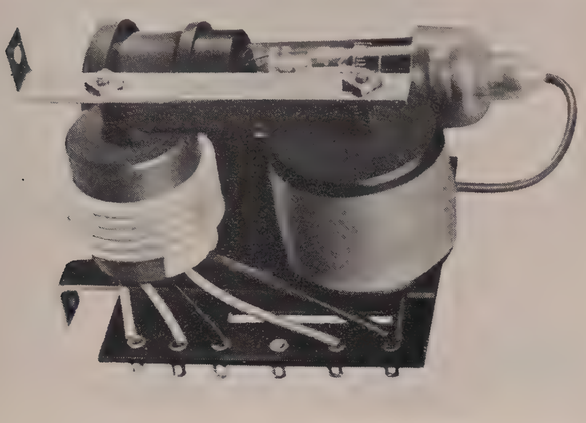
Aveley Electric Ltd. are well known for their use of toroids in producing precision transformers of all types,



(*Ancillary Developments Ltd.*)
Rectlinear potentiometers with stroke lengths varying from 13 in. down to 1 in.

but a new development is the decade tapped unit. This is housed in a box with thumb-wheel operated switches to give a digital form of reading. Three and four dial decade units were shown giving accurate division of known voltages, with an input limit of 200 V. Errors less than 0·01% are usual, and 0·0001% can be supplied in some types.

Saturable reactors, now offered in 416 versions covering the range 1 kVA to 300 kVA by **Haddon Transformers Ltd.,** were exhibited alongside conventional transformers. These devices are used for power control and in magnetic amplifiers. Feeding a small variable d.c. input to a control winding modifies the impedance of the load windings due to the change in permeability at saturation of the ferric core. This controls the power passed to any load wired in series with the load windings. Applications range from 500 kVA power installations to theatre lights control consoles.



(*Electro Acoustic Industries Ltd.*)
Desaturated line output transformer requiring no components other than those used for undesaturated techniques.

Transistors and Semiconductors

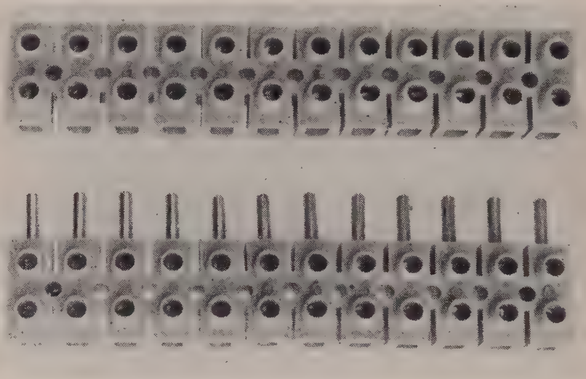
Semiconductor devices were to be seen throughout the show either as static exhibits or working models, and included numerous innovations.

The Transistor Division of **Standard Telephones and Cables Ltd.** staged an ingenious exhibit to demonstrate the higher output power and better efficiency obtainable from epitaxial transistors. Two high-frequency power oscillators were operating side by side each with a spotlight as its load illuminating a suitably inscribed card. The first oscillator used TK.200A silicon *n-p-n* type double diffused transistors to produce 5 W at 5 Mc/s, with an efficiency of 45%. The second employed epitaxial versions, the TK.202A developing 9 W at 10 Mc/s with 50% efficiency—and noticeably brighter illumination.

Epitaxy involves building up a layer of semiconductor material by the deposition of a gas, for example, silicon tetrachloride, and permits the deposition of extra thin layers of high-resistivity material on a low resistivity "backing", giving greater design flexibility. Standard Telephones also exhibited a tunnel diode digit register employing matched pairs of their new encapsulated JK.10B diodes.

Mullard Ltd. introduced many new semiconductor devices, both for industrial and domestic receiver purposes. The industrial items included a 1 nano-second avalanche transistor capable of generating short duration 60 mA pulses at high repetition frequencies, a new high speed computer logic transistor attaining switching speeds up to 50 Mc/s, and three new ranges of subminiature Zener diodes. The advance of transistor television was more than hinted at. New Mullard alloy diffused transistors were exhibited for r.f. amplication and mixer/oscillators up to 260 Mc/s, and video amplification with a factor of 200. The ACV 36-10 14 in. metal-backed tube shown, is also designed for portable transistorized sets, drawing only 165 mA heater current at 11·5 V. **Newmarket Transistors Ltd.** showed a new transistor specially developed for television scanning circuits.

At another level, **Joseph Lucas (Electrical) Ltd.** gave details of the data storage unit designed and developed by their associates **G. and E. Bradley Ltd.** This is fully transistorized, contains 180 components in a space $1\frac{1}{4} \times 5\frac{1}{4}$ in. diam. and weighs 8 oz. in unencapsulated form. It is for the Anglo-American Scout satellite due to be launched this year. The very low power required—approaching 0·6 mW per store—is derived from the satellite's solar power system.



(*Metway Electrical Industries Ltd.*)
12-way plug/socket connector blocks in flexible p.v.c. or rigid Bakelite. These can be cut to any number of ways and there are $7\frac{1}{2}$, 10 and 20 A versions.

Transfilters have already received a fair amount of publicity, auguring as they do the advance of solid-state circuitry. The **Brush Crystal Co. Ltd.** exhibited two distinct types. The T.O. series overtone transfilters have impedance matching characteristics, forming a four-terminal network suitable in interstage coupling. They can replace i.f. transformers at specified i.f. frequencies, and have a claimed frequency stability of 0·2% for 10 years. The T.F. series fundamental transfilters are used in emitter by-pass applications. A versatile new device also shown by this Company was the Statavolt. It consists basically of a number of diodes in series and/or parallel to give a reference voltage with specified current, slope resistance and temperature co-efficient irrespective of Zener voltage.

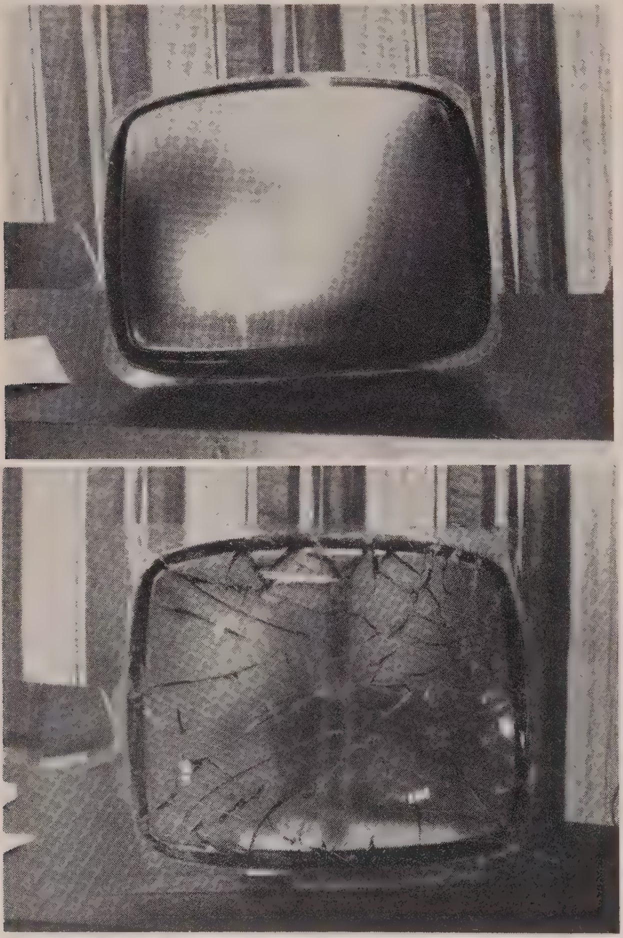
The remote control of solid state capacitors is made possible by **Hughes International (U.K.) Ltd.** with their silicon *p-n* junction capacitor. The capacitance depends on the applied d.c. voltage, and units of high Q and a wide capacitance range are available. Even newer from Hughes are the microseal "dot" diodes and transistors measuring only 0·062 × 0·03 in.

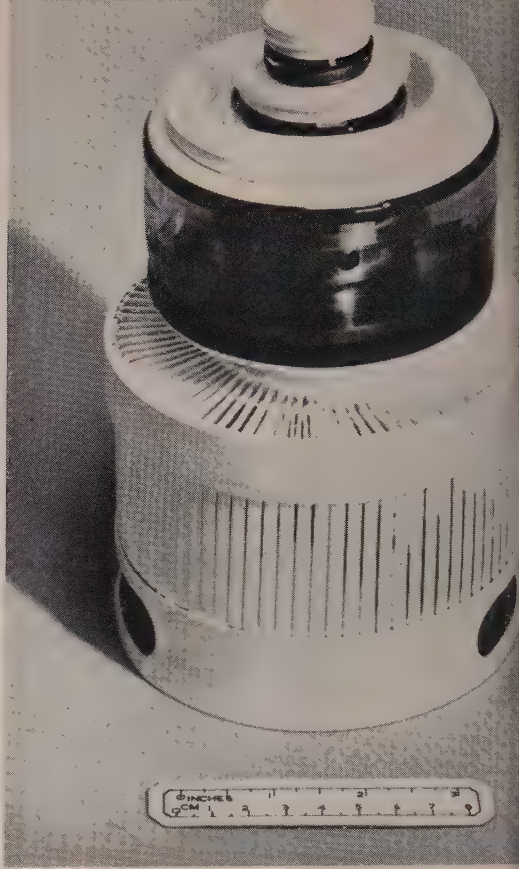
An interesting supporting exhibit, in view of the rapid emergence of power transistors, was the **Floform Parts Ltd.'s** standard transistor base. This is designed for cold weld encapsulation (the relevant rights have been assigned to Floform by **Tung-Sol Electric Inc.** and **G.E.C. Ltd.** The base provides a hermatic seal improving the thermal characteristics and reliability of the transistor.

Valves and Electron Tubes

Not surprisingly, in view of the increased versatility of transistors, the most spectacular new valve developments were in the high power fields, though small valves, too, continued to improve. In the latter category, are the new high performance **Ediswan Mazda** valves for television receivers shown by **Associated Electrical Industries Ltd.** These are frame grid types, including a triode-pentode for A.G.C. and a tetrode r.f. amplifier.

(*Cathode Ray Tubes Ltd.*)
Two photographs (*by courtesy of Mr. E. J. Millen*) showing (top) a normal cathode-ray tube protected by a Perspex implosion guard and (beneath) the effect on the guard after implosion.



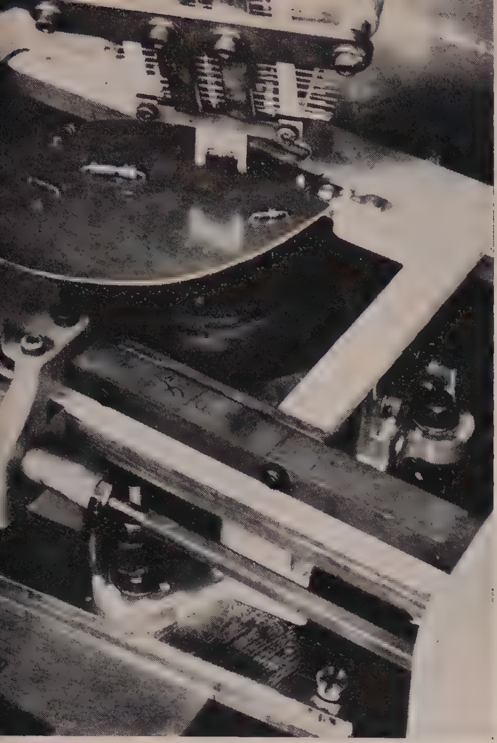


(*Standard Telephones and Cables Ltd.*)
Forced-air cooled oscillator triode. This develops 5 kW 120 Mc/s and is designed for use in r.f. heating equipment.

The **English Electric Valve Co. Ltd.,** anticipating the extension of British television to Band IV, exhibited a new type of transmitting valve. This is one of the most powerful valves of its type in the world. It is a tunable klystron with focusing solenoids and delivers not less than 10 kW c.w. at an efficiency of 40%. New, too, is the compact, forced-air-cooled oscillator triode from **Standard Telephones and Cables Ltd.,** developing 5 kW at up to 120 Mc/s.

The **Brimar Ltd.** Stand carried oscilloscope gear from such manufacturers as **Cossor, E.M.I., Telequipment** and **Marconi** to show the wide market for their Sylvania-Thorn range of electron tubes. Newest of these was a 5 in. precision helical post deflection acceleration tube. It has the highest sensibility (high sensitivity coupled with high resolution) of any known tube of its kind.

Brimar Ltd. now manufacture twin-panel teletubes which allow television sets to be made omitting mounting frames, support cradles, etc. Similar advantages result from the bonded shield tubes of **Cathode Ray Tubes Ltd.** In these a Perspex implosion guard is fused to the tube face with an acrylic substance. This is sufficiently strong to allow bolting the tube direct to the front panel. A mask can be painted on the inside of the guard, and the light output is improved by as much as 10% due to the reduced number of reflecting surfaces between the tube and the viewer.



ents being inserted into printed boards by the
ert" machine.

EYELETS and SOLDER TAGS

Their Use in the Radio and Electronic Components Field

By

H. B. WALKER

*Geo. Tucker Eyelet Co. Ltd.**

The ever changing requirements of the radio and electronic industries creates a constant flow of new problems and applications for eyelets and solder tags. Consequently many thousands of different sizes of eyelets, in particular, are turned out daily, whilst the demand for solder tags in varied forms increases steadily.

WITH the growing popularity of the printed-circuit board and miniaturization in general, the demand for small eyelets with a barrel diameter about 0·050—0·060 in. has increased considerably, resulting in the installation of more power eyeletting machines to handle these small products, which can be supplied in silvered, electro-tinned, or nickel plate finish or in plain brass. Owing to the small diameter of the eyelets a number of closing die breakages occurred during the early stages of power feeding, but the redesigning of the upper die and nipple pin has now eliminated this.

A recent development for printed-circuit boards is the funnel flange eyelet secured in the circuit by means of a flared setting. This type of eyelet, made either from brass or copper, is now widely used in America, and is designed primarily for two-sided boards. It is claimed that reliability requirements such as vibration, mechanical shock, thermal cycling and humidity have successfully been met. The 45° angle of the flange and the flared setting provide an excellent solder fillet (Fig. 1) between the under side of the flange or setting and the board, thus eliminating any chance of electrical failure due to solder separation between the flange or rolled setting of the conventional type of eyelet; apart from improved solderability the funnel flange eyelet also facilitates easier placing of a component.

There are certain limits to which the length of an eyelet can be drawn, and this length is co-related to the diameter of the barrel. Eventually a stage is reached when it no longer becomes a commercial proposition for excessive lengths to be drawn; the only alternative would be to manufacture such an eyelet from tubing thus making the product extremely expensive and greatly above the general price range. By producing a seamed or split eyelet, it is possible to manufacture a product of small diameter around 0·050 in. to a length of approximately half an inch. By following the same method, eyelets of a larger diameter can be produced up to a length of approximately two inches at a far lower cost than a similar product made from tubing.

Applications

The applications for eyelets in the allied electrical industries are infinite, as are the sizes available. In general the demand for large bulk quantities ranges from 0·080—0·250 in. diam., all in varying lengths; within this group three standard ranges have been formed namely 0·090 in. diam., in a variety of lengths up to $\frac{9}{32}$ in. and $\frac{1}{8}$ in. and $\frac{5}{32}$ in. diam. up to $\frac{3}{8}$ in. plus in length. All these sizes are manufactured from brass and are available in self colour, nickel plate, tinned, electro tinned, hot tinned or silvered finishes.

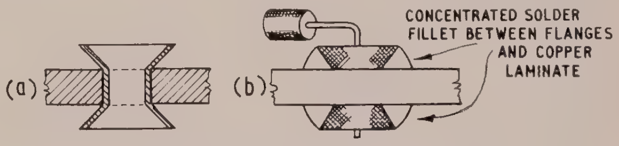

(a)
(b)
CONCENTRATED SOLDER FILLET BETWEEN FLANGES AND COPPER LAMINATE

Fig. 1. Funnel flange eyelet with solder fillet.

Of the smaller eyelets, many millions are used, usually in the assembly of such items as rotary switches, heating elements for electric irons, toasters, hair dryers and so forth, and within this category fall the small eyelets manufactured from steel and pure nickel used in radio valve construction. Larger eyelets for glass to metal applications are also made from Nilo K material.

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* **Walsall Road, Birmingham 22B.**

The use of eyelets for wire terminations has become extremely popular as they are inexpensive and easy to apply. A further application is in rough finished holes as in metal chassis, as a preventative against chafing of wire connections which often have to pass through such holes. Other popular applications include the eyeleting of valve holders, cans, tag strips and so on. Apart from the applications mentioned above, the normal function of an eyelet is to secure together two or more pieces of material usually in the form of a component to a panel or chassis or to assemble components themselves. The holes are normally pre-punched to the appropriate size, the clearance required being a minimum of 0·005 in. The resultant setting is a neat roll of metal which gives added strength together with a neat and tidy appearance.

Eyelet and Solder Tags

A large and varied range of solder tags is available and these fall into the following categories: double-ended eyelet; single-ended eyelet; double-ended flat; single-ended flat; wire-end eyelet; wire-end flat; strip form; terminal.

The double-ended eyelet tag, regardless of the introduction of the printed-circuit board, continues to form a very large proportion of present day production. This is to some extent because certain types can be fed, formed and set automatically with power tagging machines. These are available to all users of this type of tag, which must have both arms equally balanced and in the same horizontal plane with the eyelet formed in the centre of the tag.

The eyelet barrel can be either square or round, the general trend being towards the square barrel which, when seated in a square hole, reduces the possibility of lateral movement; it is, therefore, possible to make up whatever length of tag strip is required with the tags in fairly close proximity.

Apart from tag strip, other applications include the tagging of coil formers, transformers, speakers and so on. Double-ended eyelet tags are also available in numerous pre-formed shapes, but these cannot be fed automatically. Single-ended eyelet tags are also available with both square and round barrels and the single arm is supplied at various angles according to the product required. Here again the applications are similar to that of the double-ended type. Both single- and double-ended flat tags are available with various BA piercings and are normally secured to the component by means of an eyelet of the appropriate size.

To meet special requirements, miniature single-ended and double-ended tags have been produced with a barrel diameter of 0·065 in. and an overall length as small as 0·310 in. for the single-ended variety. All solder tags are manufactured from brass and are available in silvered, electro tinned, tinned, or hot tinned finishes.

Wire-end tags, both of the eyelet and flat type, are used in the assembly of silvered mica capacitors and are available in lengths varying from under one inch to three inches plus. The slender tails on these tags are especially tough and pliable to withstand a considerable amount of bending. There are two standard finishes for wire-end tags—silvered and hot tinned, with or without a nickel flash.

A number of tags are now made in continuous strip form, in some cases from pre-tinned strip and certain types are finished after manufacture. Tags in strip form are supplied on reels, as in this form the handling and feeding are greatly simplified.

Anti-corona tags are available with or without the eyelet barrel embodied, and the first mentioned can be successfully automatically fed.

A small but popular range of terminal tags is made with standard BA piercings as well as spade-ends, the terminals having a fluted and serrated arm for rolling and clinching on wire connections.

Other products available include fuse caps in numerous sizes having either a conical or flat base, pierced and un-pierced. These are manufactured from brass and are usually supplied in self colour on nickel-plate finish. Further additions include transistor cans made from nickel silver and steel, and more recently capacitor cans manufactured from aluminium, the latter now being in bulk production. Small metal pressings in a host of shapes are continually being made, many in the form of contact strips for domestic appliances.

Setting Dies

Eyelet setting dies are of paramount importance to all eyelet users. The correct setting gives maximum strength combined with a neat appearance. To achieve these results the setting die nipple should have a gradual and polished taper, over which the eyelet is forced until a "bell mouth" is formed, at which stage the eyelet has approached the base of the nipple and the most important "root" of the die itself.

The root takes the form of a pronounced radius which ends in a recessed circle. Into the latter the already bell-mouthed eyelet is forced and at this crucial stage the maximum pressure is applied by the upper die thus forcing the eyelet to curl back upon itself until virtually a solid roll of metal is produced with a minimum amount of splitting. No absolute guarantee can be given to prevent splitting, but by using correctly cut setting dies it can be very largely eliminated. The upper die should be correctly recessed to accept the flange of the eyelet in order to distribute an even pressure upon it.

This particular process is known as a "roll" setting and not only does it provide great strength but it also pulls together the layers of material eyeleted, thus tightening up the assembly in general. It is therefore commonly used for securing metal parts together such as valve holders and other components. The width of the roll can be governed by the cutting of the die.

It can readily be seen that when an inexperienced die maker attempts to produce a setting die, failure in the form of a collapsed and/or badly split eyelet barrel invariably occurs. In the first case this has the effect of making the eyelet appear too short for its original purpose and in the case of a badly split setting a certain amount of strength is sacrificed.

The amount of metal usually necessary to produce a roll setting approximates to $\frac{1}{16}$ in. on the assumption that the eyelet is a reasonably good fit in the hole provided. If, however, the holes are on the large side the setting die has to be cut so that it will expand the eyelet before setting in order to fill out the surplus space, otherwise the parts when eyeleted together may have lateral movement. When such conditions prevail a certain amount of length is lost and it may be necessary to exceed the normal allowance for the setting.

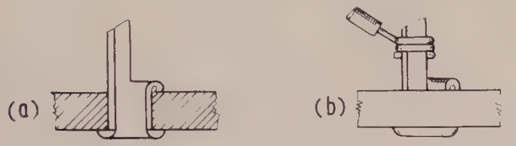


Fig. 2. (a) Section through eyelet split-set in board and (b) wire wrapped around upstanding section of eyelet to form joint.

On the question of the correct hole size to use, it is customary to allow 0·005 in. clearance for hand assembly work, but where automatic assembly is used a clearance of 0·008—0·010 in. may be necessary, particularly if a number of pieces have to be eyeleted together simultaneously and the material itself is of a rigid composition. Where material is of a flexible nature the clearance is not quite so critical, as the eyelet during its travel through the various layers is able to centre up the holes with less opposition.

Different types of settings can be achieved to meet individual requirements, and to this end the die maker should have before him the actual components that are to be eyeleted.

Special Dies

Special types of setting dies have been devised to produce wiring post and pillar type connections formed from the standard type of eyelet. To produce an efficient wiring post for printed-circuit boards the eyelet is split into four sections, either one or two sections are left in an upright position whilst the remaining sections are rolled over on to the surface of the board; the flange of the eyelet can then be soldered to the circuit on the underside of the board (Fig. 2).

The pillar lug is produced by securing the eyelet in the board by means of a rib of metal which is formed from the barrel of the eyelet during the setting operation, thus the flange of the eyelet is on one side of the board and the rib on the other, leaving the remainder of the eyelet barrel in an upright position, thus providing an ideal connecting base for either components or wire connections (Fig. 3). Both the wiring post and rib setting results can be obtained by automatic feeding and setting on various types of eyelets suitable for applications of this nature.

Settings such as four-, and six-way split flat settings are standard for such applications as the eyeleting of heating elements on various electrical appliances where strength is not a predominating factor. Other types of settings are being constantly devised. It is not practical to supply a standard blue-print giving full dimensional details of the actual setting die as these can only be arrived at by cutting the die to meet each individual requirement.

In order to facilitate speedy insertion with a minimum amount of handling, power eyeleting and tagging machines are available. The power eyeleting machine is operated by a $\frac{1}{4}$ h.p. motor in conjunction with a single trip clutch, both being built into the machine. Owing to its compact design, the machine can be transported from one position to another without undue difficulty should the necessity arise, and it must be built up to suit the eyelet chosen for the particular assembly involved.

The closing dies are made to give the required clearance for eyeleting the component and also the correct setting; for this reason it is necessary to have samples of the actual components available when the machine is built. Upon completion the machine is installed and tested by specially trained engineers.

It has already been mentioned that an automatic eyeleting machine is built to feed one particular size of eyelet, and whilst this is in general correct the machine can be built to feed an eyelet having the same outline but in varying lengths. In this case it is only necessary to adjust the lower die to obtain the correct setting pressure, this being speedily carried out by merely turning the adjusting screw at the base of the die holder in the required direction.

A variety of die holders is available, some taking the form of a post in varying lengths up to $3\frac{3}{8}$ in.; it is thus possible to eyelet box-like components such as radio chassis. Special off-set die holders can also be supplied for eyeleting such components as coil bobbins and coil formers, and it is rarely that an inaccessible assembly is encountered.

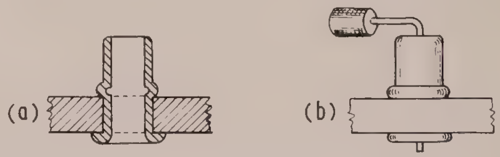


Fig. 3. (a) Section through eyelet rib-set in board and (b) component lead inserted through eyelet.

The feed mechanism is driven by the motor, and when the eyelets are placed in the hopper a constant flow down the raceway to the closing dies is obtained. A bench model eyeleting machine is also available and whilst the feed mechanism is similar in design to that of the power machine, the machine itself is operated by a foot treadle.

The tagging machine is powered by the same mechanical means as the eyeleting machine, but the feed mechanism has necessarily to be of a somewhat different design.

As mentioned elsewhere, the machine will feed, bend, and set double-ended eyelet tags whose arms are equally balanced, at the same time having the eyelet centrally located. The tags are fed by means of a revolving hopper down a race-way, where they encounter a separator which allows one tag at a time to enter the bending throats. The bending throats and former shape the tag by turning up both arms at right angles, at the same time inserting it in the panel or strip and clenching the eyelet. A variation in the form of one arm at right angles to the other can also be achieved if desired, likewise special lower dies for coil former insertion.

The machine is built to feed and set one specific type of tag and, here again, providing the outline remains the same, slight variations are acceptable.

"Dynasert" Machines

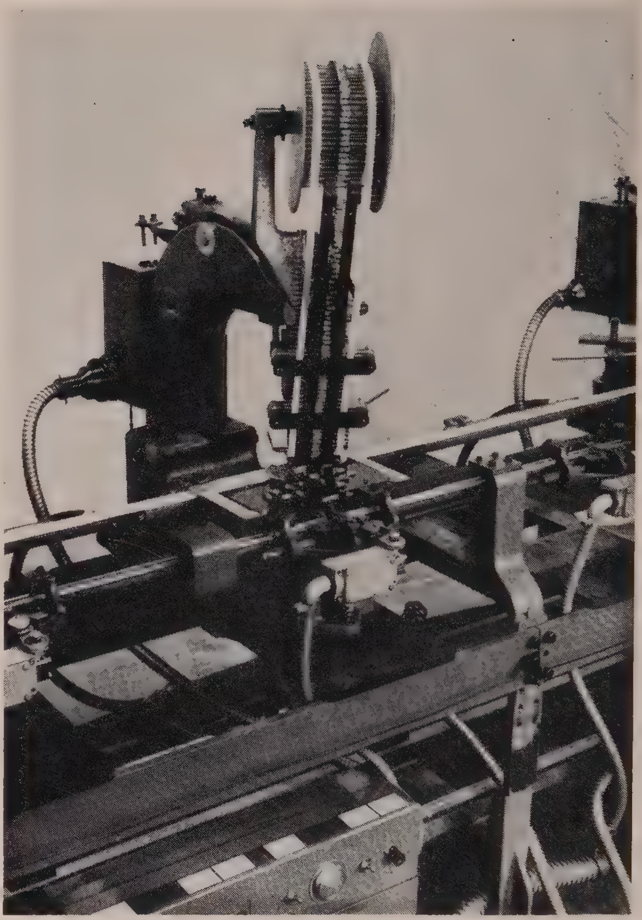
Apart from eyeleting and tagging machines, machines for the insertion of axial-lead components into pre-punched printed boards are available under the registered name of "Dynasert".

Dynasert component inserting machines for axial-lead components have been developed to handle three sizes of components. The No. 1 and 2 machines are of the same basic design, but the head of the No. 2 machine has been designed for a larger size. The No. 3 machine will insert up to the largest component likely to be employed with printed wiring boards. The action of the machine is to cut and form the leads to the required dimensions, and then to insert and firmly clinch the components to the printed board.

The No. 1 and No. 2 machines can be offered in the form of a complete conveyor unit or as separate bench models, in the first instance electrically controlled and in the case of the bench machine operated manually with foot control of the air supply which operates the inserting mechanism.

"Pop" Rivets

In describing the various die holders and special dies for eyeleting in a limited space it was mentioned that an inaccessible assembly is rarely encountered. When this situation does arise, however, "Pop" rivets generally provide the answer. This is the modern system of riveting from one side of the assembly only, and requires the use of a single operator. "Pop" rivets are manufactured from monel metal, aluminium alloy or mild steel and are available in a variety of sizes. They are tubular in form and each rivet is assembled on a steel mandrel. The rivet is placed in the tool and then inserted in the drilled holes of the layers of material to be riveted. The tool draws the mandrel back through the rivet thus drawing together the parts until the maximum amount of pressure is reached, at which stage the mandrel breaks away thus forming a really tight joint. A large "Pop" head is formed and tight joints are obtained even in holes which may be oversize.



"Dynasert" component inserting machine.

Valve holders, transformers, panels or brackets are ideal for "Pop" rivet assembly.

"Pop" riveting tools available include cranked pliers, lazy tongs, pneumatic and hydraulic guns which can be fitted with a variety of offset heads, specially designed for riveting in corners, or close to a flange on inside channel sections.

MICROPHONES

Classification, Construction and Application

By G. R. Pontzen

The first part of this article appeared in May and it was intended to publish the second part in this issue. Due, however, to unforeseen circumstances the article has had to be held over and will now appear in the August issue of *Radio & Electronic Components.*

SOME ASPECTS OF RESISTOR LIFE TESTING

By S. Osborne, B.Sc., A.M.I.E.E., A.M.I.Mech.E.

Welwyn Electric Ltd., Bedlington, Northumberland

Abstract

The environment during the test in relation to specification requirements is discussed and the air circulation is related to the cooling effect produced. The size and duration of a life test are deduced from the definitions concerning reliability. Examples are given of the presentation and analysis of test data.

Introduction

IT is the responsibility of the designer of electronic equipment to ensure that the equipment will continue to function over a reasonable period without failure. To do this he must consider what the performance of the individual components is likely to be and how the arrangement of these components will affect the main function of the equipment. The equipment will probably operate correctly in spite of the failure of certain non-critical components, such as lamps and meters. There will be other components, such as valves, capacitors and resistors, the failure of which may prevent the equipment functioning properly. The overall performance can often be improved by duplication of such critical parts, that is by using the redundancy principle, or by de-rating the individual components or by the use of the very best (and usually the most expensive) components. Factors such as size and cost usually limit the permissible improvements and the final design will be a compromise between these conflicting requirements.

Information about the individual reliability of each component is not always easy to obtain, especially with new components, but three methods are possible:

(1) the designer may rely entirely on his own experience;
(2) by keeping a record of the performance of equipment "in the field" a useful estimate can be made of the reliability of components under service conditions;
(3) by testing components in a laboratory under controlled conditions a proper statistical approach can be made.

The component manufacturer has a responsibility in the compilation of test data and this article describes some of the points which have arisen in providing for large scale tests on fixed resistors.

Before testing can commence there are many factors which have to be considered, such as (*a*) the test environment, (*b*) the number of resistors of any one type and value to be tested and (*c*) the duration of the test.

When the test is completed the results must be analysed and presented in such a way that their significance is readily apparent. Each of these points is discussed in the following sections.

Test Environment

During test the resistor may be subjected to a.c. or d.c. which may be applied continuously or intermittently. The load may be from zero to full-rated power in ambient conditions where both temperature and humidity may be varied. In practice it is impossible to test at all combinations of loading, humidity and temperature and, although a test under average conditions is necessary to establish normal behaviour, accelerated tests may also be required. Current resistor specifications such as the RCS or MIL-R series (or the forthcoming DEF series) give useful guidance about test conditions and cover most of the characteristics of the resistor, such as noise, temperature coefficient etc. With regard to performance two kinds of tests are usually included.

(1) accelerated tests, such as overload or severe climatic conditions for a few days;
(2) long-term tests, such as rated load for 2,000 hours or less severe climatic conditions for 56 or 84 days.

Since the number of specimens tested is usually small, even the long-term tests do not give much information with regard to the life expectancy of reliable components.

During a life test it might seem advisable to have humidity present at least for part of the test, but only one or two complex chambers have been designed to do this.(1) It is more usual to life-test with fairly severe conditions of full-rated power at the upper temperature category. It is usually accepted that a high film temperature, whether this is due to self-heating or ambient conditions, accelerates failure, and most resistors are rated according to some maximum allowable temperature. For carbon-film resistors the maximum film temperature allowed is about 150°C, whilst for oxide-film and vitreous-enamelled resistors the temperatures may be about 250°C and 350°C respectively.

Temperature distribution

Since the film temperature during test must be the same for each type of resistor, it is very important that the ambient temperature throughout the chamber is uniform. This is not easy to achieve in a piece of equipment designed to hold several thousand resistors without air circulation. During type approval tests it is usually mandatory that no forced circulation should be used. Table 1 gives the requirements of a few specifications with regard to test conditions during the load endurance test.

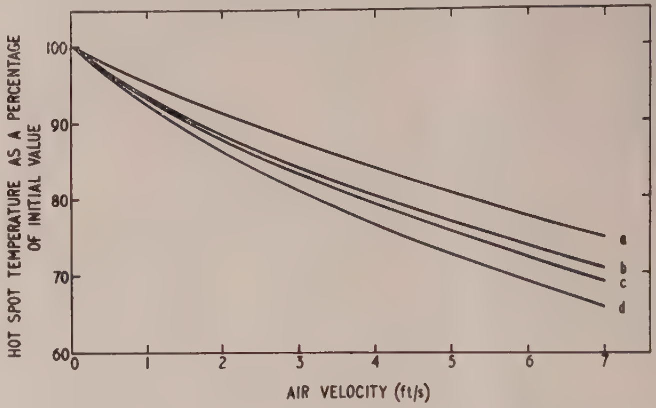
If the number of specimens is small, as in tests for type approval, the required conditions can be obtained by housing the resistors in an oven.

TABLE 1. TEST CONDITIONS DURING THE LOAD ENDURANCE TEST.

Resistor specification	Ambient temperature	Requirement for air circulation in chamber
RCS112	70°±2°C	No information
RCS113	70°±2°C	No information
RCS114	70°±2°C 155°±3°C	No information
MIL–R–11804C	25°±5°C	No forced circulation allowed
MIL–R–11C	70°±5°C	No forced circulation allowed
MIL–R–93B	85°±5°C 125°±5°C	No undue draught
MIL–R–94B	70°±5°C	No forced circulation allowed
MIL–R–9444	125°±5°C	No undue draught
MIL–R–10509B C	40°±2°C 70°±2°C	No undue draught
MIL–R–10683	40°±5°C	No undue draught
MIL–R–14293A	70°±2°C	No forced circulation
B.S.2112 Pt. 1 (1959)	70°±2°C	No undue draught (resistors in oven)
IEC115	70°±2°C	No undue draught

In large life-testing chambers elaborate precautions have to be taken to give uniform temperature distribution if air circulation cannot be used, and the equipment designed and constructed by the Electrical Research Association uses radiation shields and water jackets at the required ambient temperature.(1) In this equipment several chambers, each accommodating 1,250 resistors, have been constructed.

The disadvantage of using circulating air is due to the increased heat transfer, which produces a cooling effect on the resistor with a consequent reduction in the film temperature. This is offset by the advantage of obtaining fairly easily a uniform temperature distribution and, if moisture is present, uniform humidity throughout the chamber.



Curve	Type of resistor	Rating (W)	Initial hot-spot temperature
a	oxide film (insulated)	$\frac{1}{2}$	51°C rise
b	carbon film (lacquered)	$\frac{1}{2}$	36°C rise
c	power oxide (cemented)	4	170°C rise
d	carbon film (insulated)	$\frac{1}{4}$	22°C rise

Fig. 1. The cooling effect of moving air on the hot-spot temperature of resistors of various types.

Some simple tests have been made on a few resistors of various types and with various protective coatings to determine the cooling effect of a horizontal stream of air. The hot-spot temperature was measured by a fine-wire thermocouple wound on the centre of the resistor body. Fig. 1 shows the cooling produced by various air velocities of up to 7 ft/s. It can be seen that if the velocity of the air does not exceed 1 ft/s, then the hot-spot temperature will not be lowered by more than 7%. For accurate humidity measurements it is desirable to have a higher velocity than this (say about 6 ft/s) and it would be necessary to measure the humidity in some part of the ducting where a higher velocity can be obtained.

The load-life chamber illustrated in Fig. 2 has been designed to give an average air circulation of 1 ft/s with facilities for heating the circulating air to 70°C. The resistors are loaded on to trays (fitted with radiation baffles) which can be plugged in to the rear of the

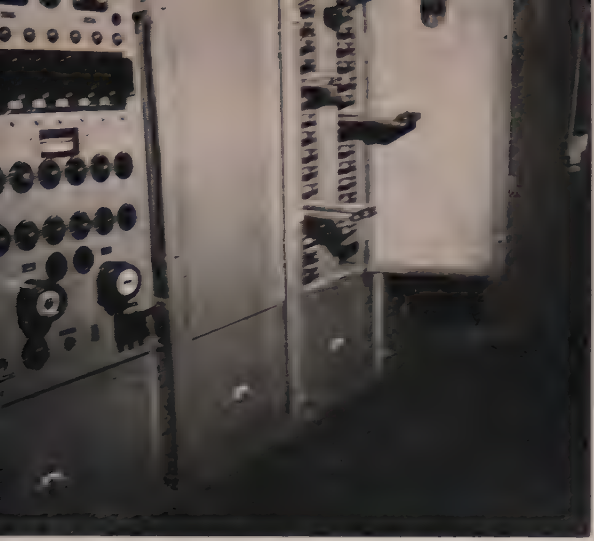


Fig. 2. Load-life chamber suitable for testing up to 5,000 resistors.

chamber for connection to the loading supply. Depending on the size of the resistors, up to 5,000 can be accommodated in the chamber. The photograph shows the trays in the centre section and the control panel at one end of the equipment.

Number of Resistors to be Tested

An accurate assessment of the number of resistors to be tested can be deduced from a consideration of the exact meaning of reliability in terms of mean life and failure rate.(2

Mean life (m)

It is assumed that the equipment is not new but has reached a steady state with failures of one particular type of component occurring at a constant rate. Owing to the replacement of these components as they fail, the ages of the components will vary, some being old and some being new. In this idealized situation the time between failures is defined as the mean life of this component. The mean life will be inversely proportional to the number of these components (n).

If the mean life of n resistors of a particular type is m hours, then the mean life of one such resistor is nm hours. This quantity we will define as the "mean life per unit".

Average failure rate (λ)

The failure rate is the reciprocal of mean life. If λ is the failure rate per unit then $n\lambda$ will be the failure rate of n resistors. In a piece of equipment with different numbers and types of components the overall component failure rate will be

$$\lambda\text{overall} = n_1\lambda_1 + n_2\lambda_2 + \quad \ldots\ldots \quad (1)$$

The mean life of the equipment will then be

$$1/n_1\lambda_1 + n_2\lambda_2 + \quad \ldots\ldots \quad (2)$$

Units. The failure rate may be stated in several ways. ll of which are used in practice. If, for instance, the mean life of fifty resistors is 1,000 hours, then one failure n fifty occurs every 1,000 hours, i.e. a failure rate of 2% per 1,000 hours, or 0·02 per unit per 1,000 hours, or 0·00002 per unit per hour.

Performance Limit

Depending on the circuit, a designer will set a limit to he amount by which a resistor will be allowed to change during its working life. Different circuits will require different levels of performance so that the manufacturer must try to estimate the reliability of the resistor for different performance limits.

Failures

These are resistors which change by more than the amount set by the performance limit.

Reliability

The mean life may be used as a measure of a resistor's reliability, but usually the failure rate is used. Standard levels of reliability have been suggested by the Rand Corporation of America and these levels are shown in Fig. 3. For each level the inverse relationship between complexity n and mean life m is indicated by a straight line if logarithmic scales are used. Each level is identified by letters R, S, etc., R representing a high failure rate and low reliability and U representing a low failure rate and high reliability.

An alternative method of specifying the preferred levels is suggested in the following definition for a "Reliability Index", which avoids the two main disadvantages of the Rand System, namely that the levels are identified in an arbitrary way not directly related to the failure rate and the failure rate is an inverse measure of reliability, i.e. high reliability equals low failure rate.

Reliability Index

It is suggested that an index of reliability should fulfil the following requirements:

(*a*) be related to mean life or failure rate;
(*b*) be of neither too small nor too large a number;
(*c*) reliable resistors should have a higher index than less reliable ones;
(*d*) the index should be compatible with the six Rand levels already being used as preferred standards.

The following index satisfies these requirements.

Reliability Index $= 10 \log_{10} M$

where M=mean life of 1,000 resistors.

Using this index and rounding off the Rand failure rates, one obtains the following table of preferred levels of reliability.

TABLE 2. LEVELS OF RELIABILITY.

Reliability index	Mean life of 1,000resistors(h)	Failure rate % per 1,000 h	Approximate Rand level
18	67	1·5	R
23	200	0·5	S
28	670	0·15	DS
33	2,000	0·05	T
38	6,700	0·015	DT
43	20,000	0·005	U

Resistor-hours required. For the test to be of value there must be at least one failure, and therefore if the Reliability Index is 18 the smallest test that can be envisaged will continue for 67,000 resistor-hours. For a more

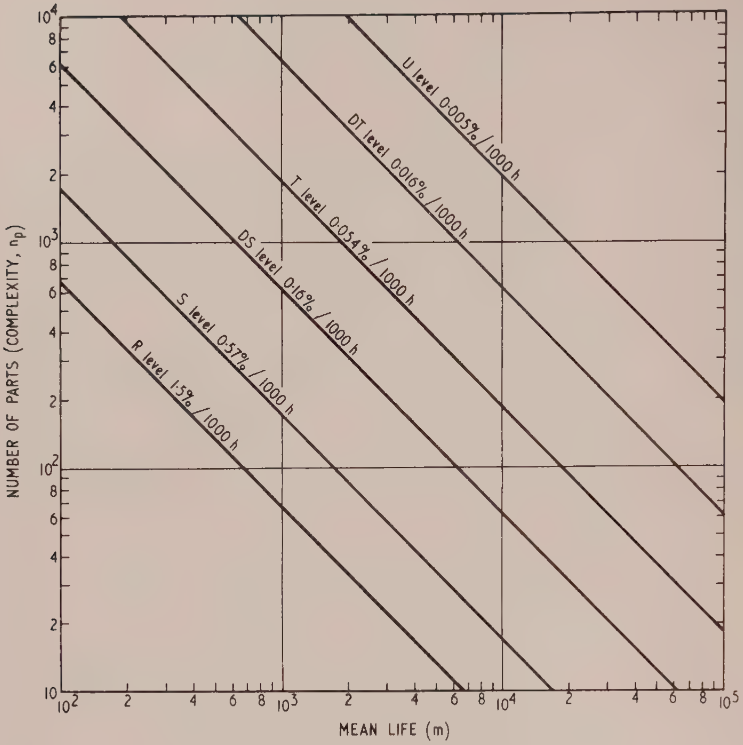
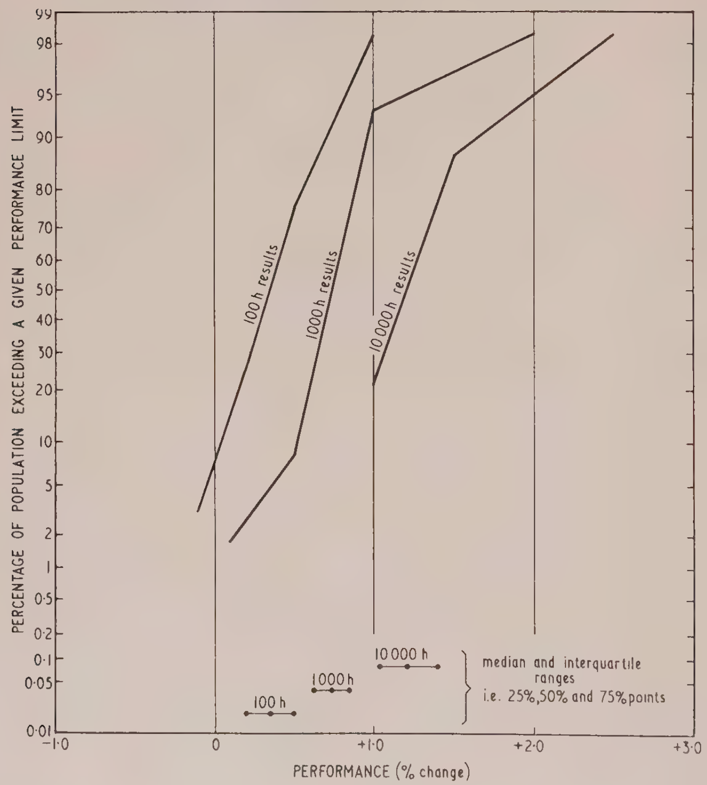


Fig. 3. Standard levels of reliability.

Fig. 4. Results plotted on Gaussian probability paper. A normal distribution gives a straight line. Oxide-film resister; d.c. load test at room temperature on 60 specimens.



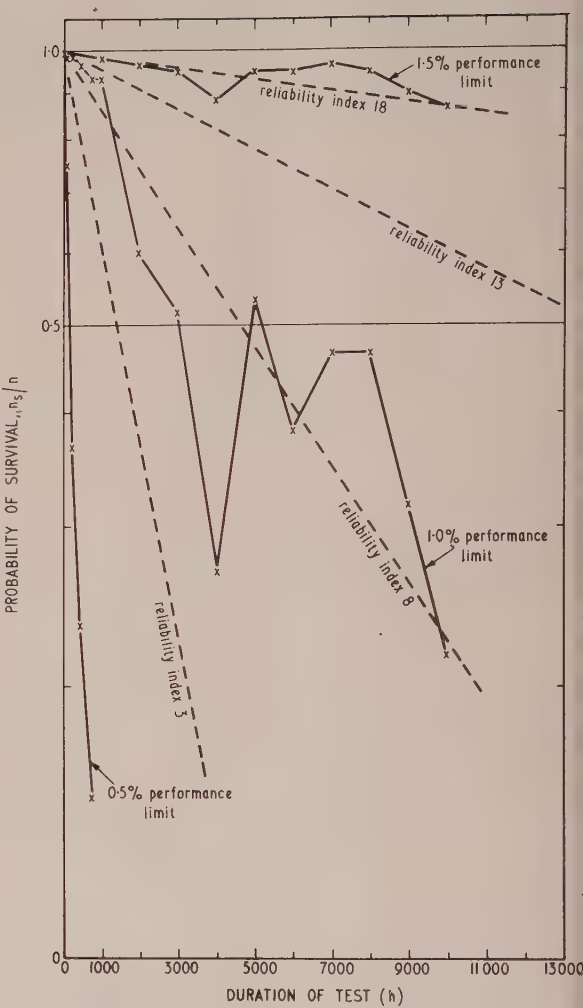


Fig. 5. Survival of oxide-film resistors during test (½ Watt room temperature).

reliable type of resistor with an index of 43 the test must continue for at least 20,000,000 resistor-hours. Such a test might involve 2,000 resistors for 10,000 hours and a test of this magnitude for each type and value is impossible. The test programme can be reduced to reasonable proportions by taking a sample of various values distributed in accordance with their actual use in equipment. High values often prove less reliable than medium and low values, but since high values are used less frequently they may not contribute greatly to the overall failure rate. From production records a manufacturer can estimate the relative popularity of different sizes and values for any type of resistor and thereby obtain guidance on the relative proportions which go on test.

Display and Analysis of Results

Measurements are made initially and periodically during the test and the percentage change of every resistor at each stage is calculated. This data has now to be condensed into a form which gives a compact picture of the test results and which will be suitable for further analysis. Since the number of resistors that have failed at various performance limits must be stated, the failure limits can be used as the boundary values for a histogram, so that the number of resistors falling between adjacent failure limits is obtained. This histogram is very wasteful of space and a rapid comparison between two histograms is not easy. A more suitable method is to use a grouped frequency table (see Table 3) with positive changes above and negative changes below the horizontal time axis.

The example shown is a test on 60 resistors for 10,000 hours and the table is equivalent to fifteen histograms. An approximate average change can be calculated from a grouped frequency table, but it is of little use if some of the changes are large or infinite as in the case of an open circuit. In the same way the standard deviation is of little use if the distribution is not Gaussian. The cumulative frequency can be plotted on "probability" paper to test if a distribution is normal (see Fig. 4).

Before the results shown in the grouped frequency table can be analysed to find the reliability index, it is important to study the way in which a life test differs from the ideal situation postulated in the definition of mean life. During a test *all* the resistors have the *same* age and failures are not replaced. As a consequence the number of survivors will decrease as the test proceeds.

Exponential law of survival

Let n be number of resistors on test, n_s be survivors at time t, and λ be the failure rate per unit, i.e. for each resistor. The failure rate of the survivors will be $n_s\lambda$. In a time δt the number of survivors will be decreased by an amount δn_s where

$$\delta n_s = -n_s \lambda \delta t \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (2)$$

(the negative sign indicates a decrease in the number of survivors).

Solving and expressing the number of survivors as a fraction of the number on test, one gets

$$n_s/n = \exp(-\lambda t) \quad . \ . \ . \ . \ . \ . \ . \quad (3)$$

This expression gives the probability of survival at any time during the test.

From expression (3), if the number of survivors is n_s after a test of T hours,

failure rate $\lambda = (1/T) \log_e (n/n_s)$ per unit per hour . . (4)

The mean life of 1,000 resistors

$$M = \frac{1}{1{,}000\lambda} = \frac{T}{1{,}000 \log_e (n/n_s)} \quad . \ . \ . \ . \quad (5)$$

To determine whether the test has proceeded in accordance with the exponential law, one can plot $\log (n_s/n)$ against t, and if the exponential law has been followed a straight line will be obtained. Fig. 5 indicates the results in the grouped frequency table plotted in this way. If the proportion of failures is large, any divergence

TABLE 3. GROUPED FREQUENCY TABLE. DISTRIBUTION OF RESULTS ON 60 OXIDE-FILM RESISTORS TESTED AT FULL LOAD FOR 10,000 H.

Duration (h) / Change %	16	100	250	450	750	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
3·5—2·51						1	1	1	1	1	1	1	1	1	1
2·5—1·51			1	1	1	1	2	2	6	2	2	1	2	5	7
1·5—1·01		1		1	3	3	22	26	37	25	34	30	29	35	39
1—0·501	1	14	37	44	47	51	35	30	16	31	22	26	27	18	13
0·5—0·201	13	30	20	12	8	4	1	1		1		1	1	1	
0·2—0·101	10	6	2	2							1	1			
+ 0·1—0·001	9	4			1	1									
— 0—0·099	10	3													
0·1—0·199	6														
0·2—0·499	6	2													
0·5—0·999	5														

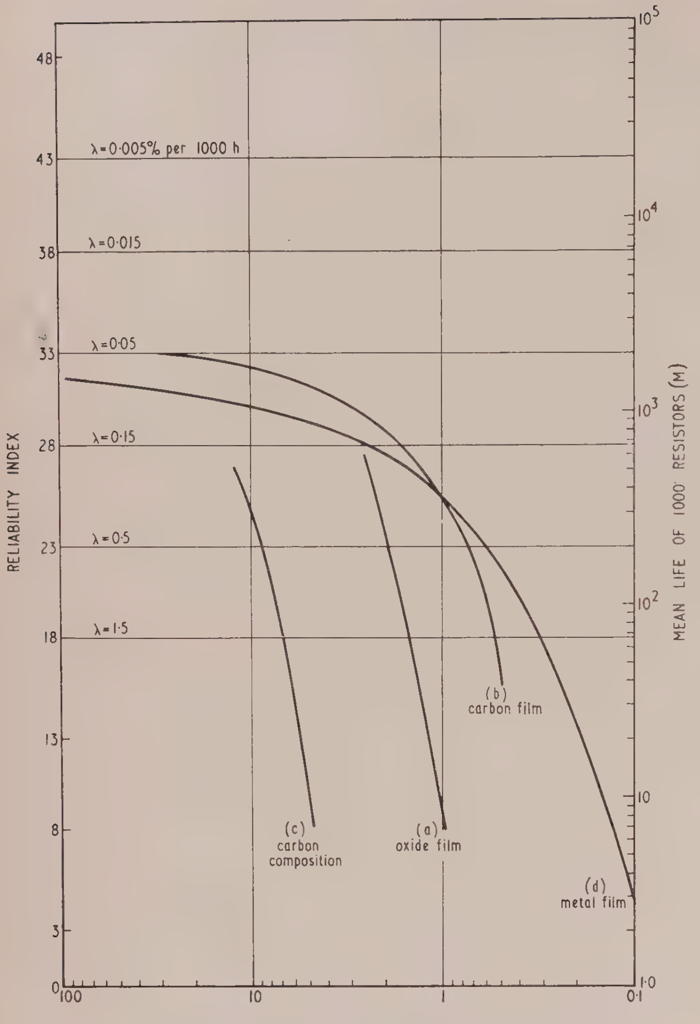


Fig. 6. Reliability of different types of resistor.

from the exponential law is easily seen, and the average failure rate can be calculated with confidence.

Finally, the Reliability Index can be plotted against the performance level (see Fig. 6) to show, on a single graph, the reliability of different types of resistor. This presentation is very useful to the designer when he has to make a choice between several types of component. It clearly illustrates the difference between reliability and stability, and the dependence of one on the other. The statement that one type is more reliable than another is meaningless if the performance limit is not taken into account.

Examples of four such curves are given in Fig. 6 and, although the four sets of results do not relate to identical test conditions, some very useful points can be made by comparing the relative positions and shapes of these curves.

(*a*) *Oxide film.* The results on 60 resistors tested for 10,000 hours full load at normal room temperature and taken from grouped frequency table (see Table 3).

(*b*) *Carbon film.* The results on 250 resistors tested for 12,000 hours full load at 70°C and taken from a report issued in 1957 by the U.S. Signal Corps Engineering Laboratory. These resistors were the best of there different manufacturers.

(*c*) *Carbon composition.* The results on 370 resistors tested for 10,000 hours full load at 70°C and taken from a report issued in 1957 by the U.S. Signal Corps Engineering Laboratory. These resistors were the best of three different manufacturers.

(*d*) *Metal film.* The results on 1,615 resistors (of various types and values) tested for 1,000 hours full load at 100°C.

From these curves several interesting conclusions can be deduced. Both the carbon-film and the metal-film curves tend to flatten out, and this is due to the small proportion of resistors which change by a large amount or become open-circuited. With a performance limit of 1% the reliability of both types is the same, and for better performance the metal film is more reliable. If a change of greater than ±1% can be allowed, the carbon film has a slightly higher reliability.

The curve obtained for the oxide-film types is similar to that obtained for the carbon-composition type of resistor without any tendency to flatten out. This is due to the fact that no open circuits (or very large changes) occurred during the tests. The oxide-film resistor is, however, about five times more stable than the composition type.

The curves shown have not been obtained from tests made under identical conditions and therefore the relative positions of these curves will not be exactly as shown. In the tests on carbon-film resistors two other types were tested. These resistors had a poorer reliability than those shown, the curves being of similar shape to (*b*) but at lower levels of reliability.

Extreme Reliability

Extremely reliable resistors require special mention. With resistors having a reliability index of 43, one failure can be expected to occur every 20 million resistor-hours. In order to maintain such a high level of reliability stringent quality control is necessary.

On small quantities of reliable components a certain amount of testing can be done to detect incipient failures. The resistor may be checked for current noise, since there is a distinct correlation between the tendency to change value on load and noise level (on carbon-film resistors). In addition, a preliminary load may be applied for about 16 hours in an attempt to detect unusual behaviour. An example of this empirical and expensive method of improving the reliability of individual resistors is found in resistors used in submarine repeaters, which are scrutinized at every stage in production and then subjected to a final load test to eliminate any that behave in an unusual way.

Future Trends

As components improve and become more reliable it is essential that larger test programmes be put in hand. Automatic measuring equipment is now being used in conjunction with digital computers for the final analysis of results.

There is a need to specify the conditions that should be used during life testing so that the results of such tests are universally acceptable.

Acknowledgment

The author is indebted to the Directors of Welwyn Electric Ltd. for permission to publish this article.

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Articles Provisionally Scheduled to Appear in Future Issues of this Journal

The Stability of Permanent Magnets.

Problems in the Manufacture of Mass Produced Precision Pressings (Parts 2 and 3).

An Introduction to the Use of Transistors in Experimental Work (Part 2).

Microphones (Parts 2 and 3).

Transformers in the Electronics Industry (Parts 2 and 3).

Hermetically Sealed Nickel Cadmium Accumulators.

Plastics and Ceramic Materials.

Fusing.

Superconductive Circuitry.

Use of Glass Fibre in Electronic Components.

Impact Extrusion of Transistor Bases.

Retainers and Fasteners.

Recording Heads.

Problems Involved in the Manufacture of Sub-miniature Radio and Electronic Components.

Thermofit Caps.

Application of Tesamoll to the Radio and Electronic Components Field.

Vacuum Forming of Plastics in Relation to Radio and Electronic Components.

Components for High-fidelity Equipment (Parts 1, 2 and 3).

Glow-discharge Tubes (Parts 1, 2 and 3).

Plastic in the Manufacture of Components.

Maintaining Specified Standards for Components.

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Termilode Waveguide Loads.

Survey of Wound Cores.

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Chemical Etching of Silicon.

Avalanche Transistors.

Trigger Circuits for S.C.R's.

Examination of Spike and Flat Leakage in TR Cells.

The list does not include the regular features, i.e., New Components, Activities in the Industry, Manufacturers Publications and Personalities. Other additions will be reports on Conferences and Exhibitions, together with news features, articles and items of topical interest.

SCIENTIFIC WELDING

In the Components Field

By "TITAN" Works Controller, Barimar Ltd. (Scientific Welding Engineers)

WHEN one mentions the subject of welding to radio and electronic engineers, more often than not they think in terms of spot welding or some other automatic system accomplished by pressing a pedal or pulling a lever. Often the timing of the operation is electrically regulated and outside the control of the operator. In short, no real skill is needed.

The foregoing is in complete contrast to what the writer has in mind, which is scientific welding designed to deal with fracture, wear and corrosion in metal of every kind. This infinite variety demands experience and ability of the highest order so far as the specially trained operators are concerned, with top class supervision and inspection plus complexity of equipment. All these things play a vital part toward a repair service upon which manufacturers are depending more and more for better maintenance at less cost.

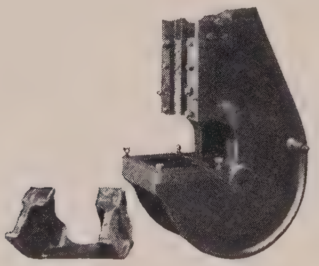

Fig. 1. For the production of the millions of components required by the radio and electronics industries, the power press of every conceivable type is indispensable. Used under normal conditions they never fail as they have a wide margin of safety. Incorrect adjustments and overloads, however, can have disastrous results, as in this case.

Any impression that the foregoing is touched with exaggeration can be dispelled with a few practical illustrations. Probably the most frequent need of the industry, whose interests are the main concern of this *Journal*, involves presses, many of them being highly specialized. Sometimes the fault is a broken main casting which may be the result of an error of judgment on the part of an employee. In rarer instances breakage is due to an insufficient margin of strength. To those unversed in repair work of this kind it may appear that procedure is simple, completely overlooking the fact that the most difficult achievement and the hall mark of superlative work is the retention of spot-on alignment. With precision welding the standard tolerance is no more than a thousandth part of an inch whilst the repair is invisible and the margin of strength definitely increased.

Maintenance and Repairs

Maintenance and repair needs are met far too often by using makers' replacements. This is always a costly procedure, particularly when renewals are purchased as a stand-by against possible trouble. The usual fate of such stocks is the scrap-heap after years of storing and the machines they were intended to support are renewed. There is also the important point of idle capital.

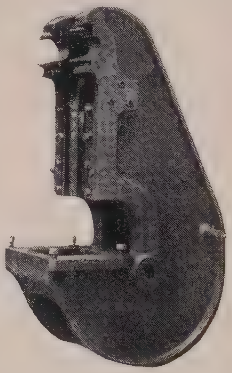

Fig. 2. There is no need to scrap a valuable press casting like this—nor wait a long time for a replacement. At relatively low cost and in a matter of days, a permanent repair is made by scientific welding. The press is as strong and efficient as it was before. (A Barimar repair.)

If reliance is placed on a replacement being immediately forthcoming from the makers, often there is disappointment and delay. Thus, by far the most businesslike approach is to utilize the resources of scientific welding, the cost being only a small fraction of the price of renewal. In addition, most repairs are completed within twenty-four hours of the time of receipt, this being the case even when subsequent machining is necessary. In this connection, welding specialists have fully equipped machine shops for undertaking work that may vary from the cutting of a small gear wheel to grinding a crankshaft that has been re-united after breakage. All work of this kind is guaranteed on a money-back basis thus absolving owners from any fear of risk as to the outcome.

Dies, Corrosion and Wear

Nowadays, some manufacturers produce their own plastic components which implies the use of costly dies. Here, again, knowledgeable welding is the answer when dies are cracked or otherwise damaged. Indeed, one can go further as from time to time existing dies are modified by welding methods thus saving both time and money.

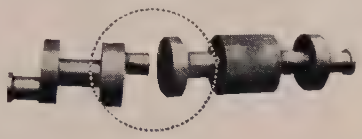

Fig. 3. Breakages to crankshafts are now infrequent. This is true of crankshafts used in presses and other machines, as well as those belonging to stationary and vehicle engines. Here is a somewhat unusual type of shaft that has broken.

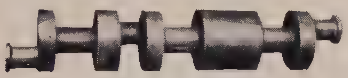

Fig. 4. The repaired shaft must have adequate strength and be in perfect alignment—two demands that the welding specialists meet to the letter. This type of repair is not expensive. (A Barimar repair.)

Corrosion is a trouble that does not afflict many machines in the industry but, in passing, it may be mentioned that by the application of stainless steel, or possibly a non-ferrous metal, depending upon the conditions of service, not only can the fault be eliminated but any further tendency toward a repetition of the same trouble is strongly discouraged.

Particularly useful is the facility with which skilful welding can solve problems of excessive wear. Usually this is done by applying specially hard wear-resistant grades of steel. Experience proves that the life of components so treated is doubled and even trebled.

Some of the parts handled are extremely small whilst others are massive and, as in the case of large boilers, are best handled on the site. If the need is in the nature of an emergency then operators with self-contained portable equipment are available at any hour of the day or night to leave immediately and deal with the trouble.

On several occasions the demand has been to strengthen presses so that they can undertake heavier work or operate more speedily. Although increased strength can be achieved invisibly there is a limit, to this and, if a substantial rise in the safety factor is requested, then neatly shaped cheek pieces are welded in position and in this way strength can be doubled.

Occasionally some special circumstance rules out the use of heat. In such cases a mechanical process is employed. This is termed metal "stitching" and gives an ample degree of strength; it is covered by the same guarantee as the more usual welding.

Conclusion

One reason for the certainty of a successful outcome to all work undertaken, apart from the basic skill and techniques applied, is that all work is under the supervision of a metallurgical chemist, one of whose duties is to ensure that the welding in no way interferes with the characteristics of the metal being handled. In addition, inspection methods are searching. To this end gamma-ray machines serve a vital purpose in that they enable the weld to be inspected in depth. Thus quality is confirmed, the remote possibility of a flaw is made impossible and, equally important, the requisite degree of penetration into the parent material is confirmed.

Although only a few of the resources offered have been mentioned briefly, it will be clear that as a means for achieving greater economy in maintenance and repair work, coupled with increased dependability and permanency of result, scientific welding is without equal.

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Photomultiplier Tube Symposium

A SYMPOSIUM on "Photomultiplier Tube Applications" will be held at EMI House, Manchester Square, London, W.1. from 13—15th September, 1961.

The aim of the symposium is to provide an exchange of information on the application of photomultiplier tubes in a wide variety of scientific and industrial fields, and to encourage discussion on the ways in which improvements can be made and new fields opened. To this end, a number of visitors from overseas who are experienced in this line are being invited.

Speakers will include experts in various fields of photomultiplier tube application, such as nuclear energy, spectroscopy, astronomy, upper atmosphere research, television and printing. They will come from government and university research laboratories and industry, in the United Kingdom and abroad.

To facilitate discussion in a relaxed and intimate atmosphere, the numbers attending will be limited, so early application is invited for application forms to EMI Electronics Ltd., Valve Division, Hayes, Middlesex.

A nominal fee will be charged, to include a copy of the proceedings which will be sent to registrants shortly after the symposium.

Aerial Isolation for Television Receivers

By A. Bowman, A.M.I.P.E., A.B.I.R.E.*

IN order to meet one of the safety requirements of the British Standard 415 in domestic television receivers, it is necessary to isolate the aerial system from the supply mains, to remove the danger of shock to persons coming into contact with the aerial.

In a.c.-only receivers this isolation is achieved by means of the normal double-wound mains transformer, which obviates the necessity for one side of the mains to be connected directly to the chassis. Conversely, in a.c./d.c. receiver design, it becomes almost imperative that one side of the mains be connected to the chassis, which forms the conventional earth or ground system for the whole receiver circuitry.

It is on the a.c./d.c. type of receiver that problems arise when isolation of the aerial terminals is attempted with the use of conventional components and circuitry.

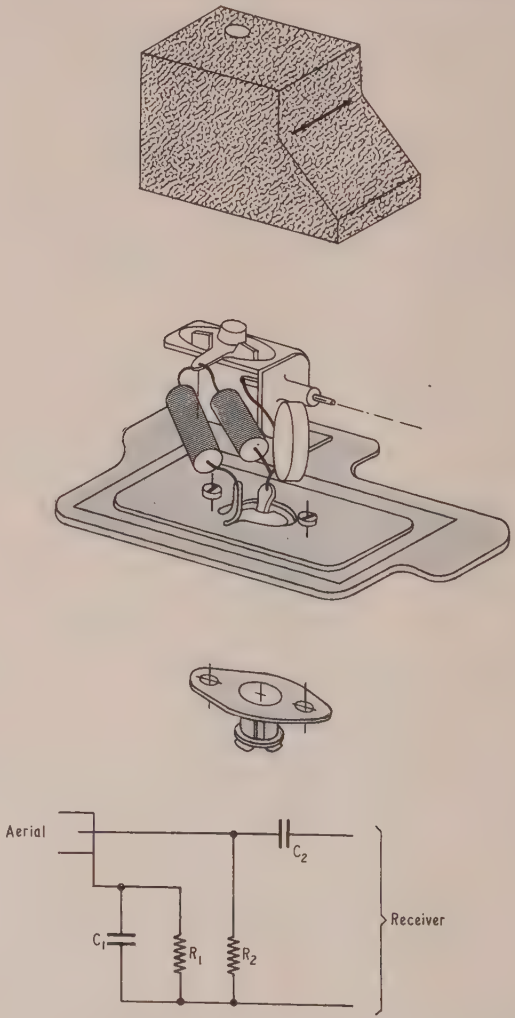
Normal methods of aerial isolation

Fig. 1 shows a typical version of the normal means employed to obtain "aerial isolation" from mains-borne power, whilst allowing incoming signals to reach the receiver input circuit.

The capacitors C_1 and C_2 in series with the inner and outer leads of the coaxial aerial feeder cable, are chosen to have a value which presents a small reactance at television signal frequencies but high reactance at mains frequencies, a common value being 470 pF.

The resistors R_1 and R_2, in shunt with the capacitors, offer leakage paths of high resistance to prevent the building-up of high voltages across the capacitors by static charges forming on the aerial system. Without such leakage paths, high voltages can appear across the capacitors and are liable to cause breakdown and puncturing of the dielectric, thus opening up the possibilities of short circuit and direct connection of mains to aerial. The value of resistance employed as a shunt must be high enough to prevent significant current flow due to mains voltages; B.S. 415 stipulates a limit of 0·3 mA from the whole of the aerial group of terminals when the set is operated at its rated voltage and frequency.

Fig. 1. Normal method used to isolate aerial from mains supply.



Whilst in theory it would appear that conventional components meet the full requirements of such a circuit, this is not so in practice.

One of the shortcomings of normal components is the difference in characteristic impedance of the physical circuit employing them to that of the feeder cable itself, causing reflections which give rise to standing waves on the feeder cable with an attendant loss of performance.

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* Egen Electric Ltd., Canvey Island, Essex.

This defect becomes more serious as the physical size of the circuit components and wiring is increased. Whilst it is likely that, in any circuit used for domestic television receivers, mismatching is going to be present to some extent, the degree of mismatch needs to be kept to a minimum.

Owing to self-inductance of capacitors and component leads, a certain amount of unwanted inductive reactance occurs in the circuit and can have the effect of preventing the outer of feeder cable from being brought down to a "cold" earth on the chassis. The capacitive reactance of coupling capacitors must be a compromise, as a high reactance is required at mains frequency, calling for the use of a comparatively small capacitor which will still have appreciable reactance at signal frequencies, causing losses and poor "noise figure" performance.

With the self-inductance of the capacitors, the situation is of course reversed. The nominal values of inductance present in conventional components are so small that they give no useful additional reactance at mains frequency, where it would be helpful, but can present appreciable reactance at signal frequencies. It therefore becomes essential to use capacitors of very low self-inductance, a condition which in general implies that the capacitors must be short in length, large in cross-section and without leads. This state of affairs gives rise to difficulties when trying to maintain clearances that are sufficient to meet with safety the high voltages applied during tests and in use.

Conventional resistors of sufficient rating to meet the requirements of the circuit are comparatively large (1 W being typical), and being subject to the application of high voltages, suffer from the fact that they are essentially single-path components and are liable to go "open circuit" when subject to short-duration high-voltage pulses. Here it is desirable to use multi-path resistors, which give a greater insurance against open circuits occurring. The specification requires the resistor to withstand 10 kV pulses without undue change of value.

The wiring required to connect conventional components itself presents a hazard because of the inductance of even a short length at the highest signal frequencies currently in use. It will be shown later that to overcome this difficulty it has been necessary to "design out" the wiring altogether, by producing special components whose shapes lend themselves to a "wireless" circuit.

Lack of screening at the front end of a receiver can cause many troubles, including patterning, self-oscillation of input stages, intermediate frequency pick-up etc.

It will be realized that when using conventional components, mechanical considerations make it virtually impossible not to expose the inner conductor of the feeder.

In present practice some attempt to reinstate the screening is made by enclosing the physical circuit in a screening can, but total and efficient screening by this method is difficult, if not impossible, if cost is to be kept at a reasonable level. This then implies another set of conditions that any special new components must meet, i.e. maintenance of coaxiality.

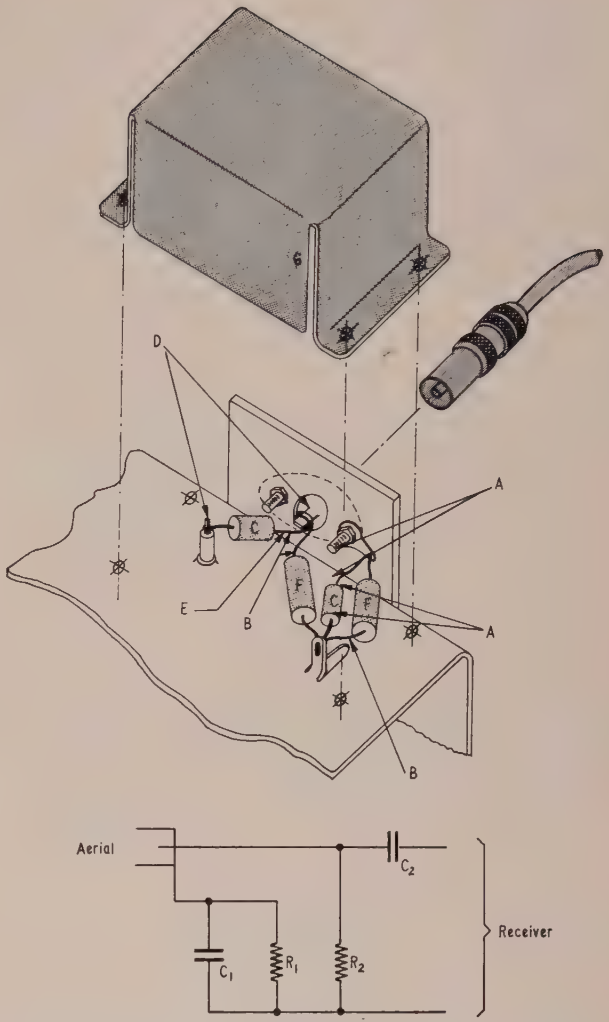


Fig. 2. Normal method used to isolate aerial in a.c./d.c. television receiver.

In addition to functional requirements, a circuit such as the one under discussion, must pass a number of tests in order to conform to recommended safety standards. These requirements can be summarized as follows:

(i) it must not be possible for more tham 0·3 mA leakage current to be drawn from the exposed parts of the circuit whilst in normal operation;

(ii) where exposed parts are nearer than $\frac{1}{2}$ in. to live parts, means for preventing accidental bridging must be provided;

(iii) insulation between exposed and live parts must be capable of withstanding high d.c. voltages for 1 min without failure or brush discharge. (On 240 V mains supply this test voltage approaches 3 kV);

(iv) air gaps used as insulation must be at least 3 mm wide and creepage paths at least 4 mm in length;

(v) The capacitors must be able to withstand approximately 3 kV d.c. for 1 min and be suitable for use over long periods (3,000 h) with 300 V a.c. applied, and to withstand 350 V d.c. at elevated temperature (70°C) whilst maintaining good insulation resistance;

(vi) the isolating resistor must be capable of withstanding 50 consecutive discharges, at 5 s intervals, of a 1,000 pF capacitor charged to 10kV;

(vii) it must be impossible to contact any live part by introducing a wire of any sort into the aerial socket.

Fig. 2 shows another typical arrangement used to produce the required circuit for aerial isolation of a.c./d.c. television receivers. The defects discussed, together with the features which fail to meet safety requirements, occur at the points shown:

- *A*, Less than $\frac{1}{2}$ in. clearance to prevent accidental bridging;
- *B*, inductance of leads;
- *C*, inductance of capacitors;
- *D*, distance over which mismatch conditions occur;
- *E*, exposure of inner conductor;
- *F*, single-path resistors;
- *G*, lack of complete screening.

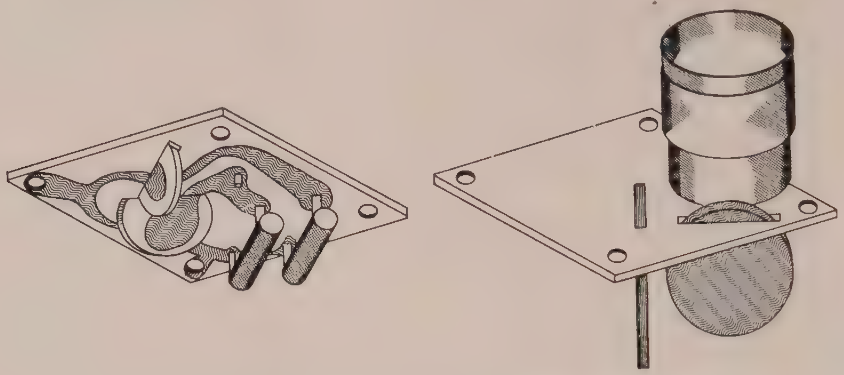


Fig. 3. A later method of aerial isolation using printed wiring components.

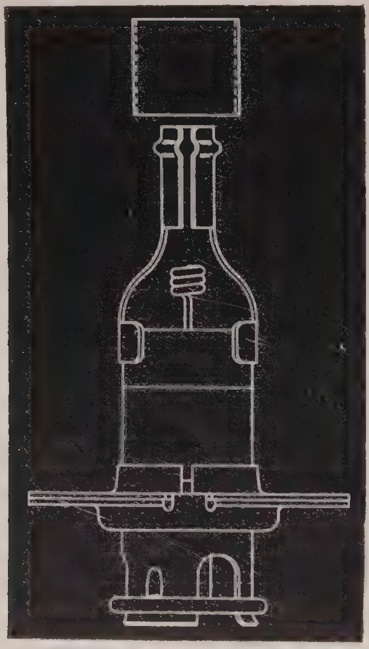


Fig. 4. Use of tubular capacitors to retain coaxiality in aerial isolator.

Apart from functional requirements the physical circuit occupies an appreciable amount of chassis space, a feature which is becoming more important with the general reduction in the size of receivers.

Given unlimited resources it is possible to design a physical circuit which will eliminate most of the objectionable features discussed, but as is only too well known in the domestic receiver industry, the cost of the circuit is usually placed very high in order of importance, so that for any new arrangement it is necessary not only to design circuitry that is superior in performance, but as cheap or cheaper than existing methods.

Bearing in mind that with the advent of u.h.f. bands, most existing arrangements for aerial isolation become inadequate owing to the much greater effect that the defects discussed present at these higher frequencies, it is now realized that some new approach is required to the problem in order to achieve the performance required at suitably low cost.

Various attempts have been made to solve this problem but they have resulted in little change of design. All these attempts have resulted in the use of normal type components, connected into circuit by both conventional and printed-board methods. (Fig. 3)

Attempts at retaining coaxiality have led to tubular capacitors being used, one inside the other, but with little success because of the fragile nature of such components and the excessive inductance introduced by their physical length. (Fig. 4)

Revised design of aerial isolator

A new solution to the problem of aerial isolation can be seen in a composite component just released for production by Egen Electric Ltd. under the title of Aerial Isolator, Egen Type 364, a description of which is given below.

Fig. 5(*a*) shows a sectional view of the assembly with the various parts lettered. Fig. 5(*b*) is the modified circuit arrangement, this being equally effective as regards function. It can be seen that the inner conductor *A* is connected in series with a disc ceramic capacitor *B*—corresponding to C_1 in Fig. 5(*b*). The shape of this capacitor meets with the requirements previously dis-

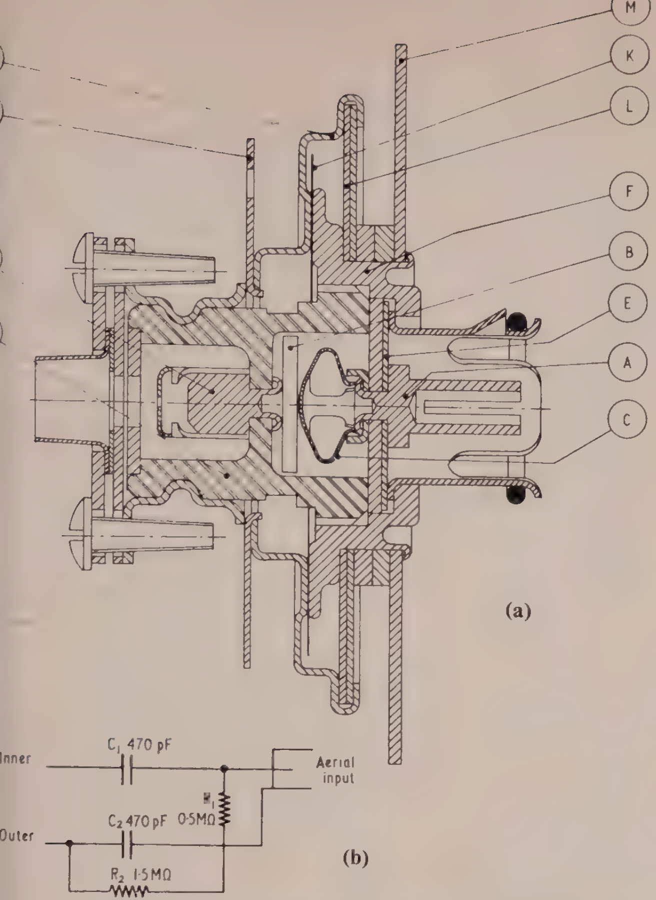


Fig. 5. (a) sectional view of aerial isolator Type 364. (b) Modified circuit arrangement of (a).

cussed, i.e. short in length and devoid of any wire leads or the like to maintain minimum inductance. Capacitor *B* is held under the spring tension of part *C* which itself has been designed to have four parallel paths to minimize inductance.

The socket *A*, capacitor *B*, spring contact *C* and plug *D*, together complete the inner feed-through circuit and are all completely surrounded by the component parts forming the outer conductor. Complete coaxiality and full screening is thus attained.

Connected between the inner conductor and outer conductor at the input end is a disc-form resistor *E* corresponding to R_1 Fig. 5(*b*). Here again no wire leads or soldering are involved and the resistor, shown enlarged in Fig. 6 offers a multi-path leak from inner to outer conductor.

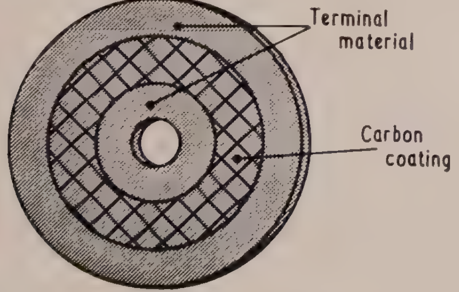


Fig. 6. Disc resistor.

The outer shell of the input socket *F* together with the outer shell of the output end *G* form a capacitor where they are separated by a silvered mica washer *K*, corresponding to C_2 Fig. 5(*b*), which is effectively in series with the outer conductor. Being of extremely small physical length and large cross-sectional area, it has a very low value of self-inductance.

A large diameter disc resistor *L* is connected between outer shell *F* and outer shell *G* so forming a multi-path leak corresponding to R_2, Fig. 5(*b*) in shunt with the capacitor formed by mica disc *K*. A large disc of insulating material *M* is positioned to prevent accidental bridging between the exposed input socket assembly and the outer shell of the output end, which is connected to the chassis by means of the fixing plate *N*. This disc also assists in meeting probe tests as required by B.S. 415, which are applicable to the terminals in particular. Means are provided for easy connection of coaxial cable, as shown in Fig. 7. The input socket will accept a normal coaxial plug to R.E.C.M.F. recommendations.

The whole assembly is built up around a high grade nylon insulator *P* and all metal parts are simple turnings, pressings or die castings, staked or riveted together to form all the electrical interconnections required to complete the circuit. No soldered joints are used in the construction nor do any connecting wires, as such, exist to give unwanted inductance effects.

The various clearances and creepage lengths required by B.S. 415 are maintained and the whole unit is closed up into an almost hermetically-sealed component, which is dustproof and highly resistant to humid conditions.

Fig. 7. Method of clamping coaxial cable.

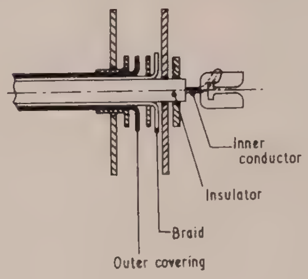
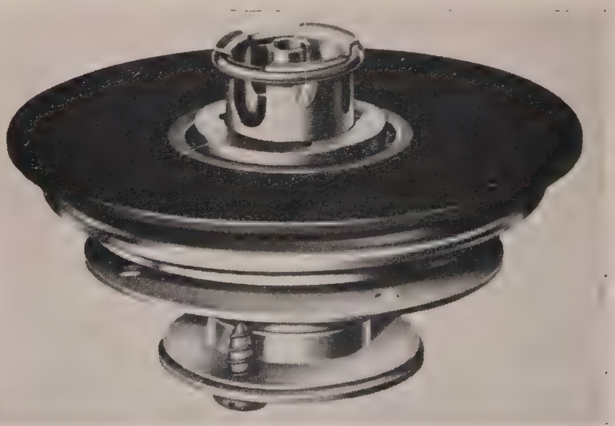


Fig. 8. Photograph of aerial isolator Type 364.



The choice of materials used reduces to a minimum the effects of electro-chemical potentials and other forms of corrosion.

The space occupied inside the chassis is small compared to that required for conventional arrangements, the whole unit being very compact and robust. (Fig. 8.) Owing to the method of construction, the cost of the isolator compares favourably with costs of existing arrangements.

It is believed that this component is the first and only commercially available product which meets all requirements of B.S. 415, as applicable to aerial terminals on a.c./d.c. equipments.

Measurements carried out to ascertain the performance of the isolator gave the following results at the frequencies shown:

Performance of the Isolator at Various Frequencies

	50 Mc/s	500 Mc/s	800 Mc/s	900 Mc/s
V.S.W.R.	<1·2	<1·57		<1·38
Insertion loss	<0·3 dB	<0·5 dB		<0·5 dB
Noise figure deterioration from that obtained, using only a standard socket without any isolation ...			<0·4 dB	

Measurements were made with the aid of a Type 803 A v.h.f. Bridge and a Philips Type A.T. 6321 v.h.f. Tuner, while conversion was carried out on Smiths' Charts.

ELECTROSIL LTD.

ELECTROSIL LTD. is a newly-formed marketing company, controlled by James A. Jobling & Co. Ltd. of Sunderland and Corning Glass Works of Canada Ltd. The new company is located at Colnbrook-By-Pass, near Slough, Buckinghamshire and will market the range of electronic components manufactured by its principals.

Common to all the components to be available from Electrosil Ltd. is the use of various forms of engineered glass as the base, the dielectric or the encapsulant. The initial range of components is as follows:

Resistors

Type N. These are made by bonding a metal oxide film of consistent thickness and resistivity into the surface of an alkali-free glass rod of optical quality. The film is robust, impervious to moisture, unaffected by the heat of soldering and more abrasion resistant than the surface of the base glass. The resistors have been especially designed for high gain—low signal amplifiers, high-frequency circuits, test equipment and for computers and missiles where long-term stability and reliability and good shelf life are essential. A large number of Type N.20 resistors rated at ½ W have been tested under computer operating conditions for a period of more than 30,000 h. A group consisting of 150 resistors, operated at 140% overload for this period, showed a resistance drift of on 1%. There were no catastrophic failures during the whole of the test run—on the basis of which, the median life for the Type N.20 resistor at rated wattage and within ±5% of nominal resistance would be 63 years.

Type CJ. The manufacturing process involves bonding a metal oxide film on to the surface of an alkali-free glass rod at red heat. The film has the same properties as that for the Type N resistors. The ohmic value is obtained by an electronically controlled spiral cut into the glass of even distribution along the resistor. End caps with welded leads assure a rugged and reliable construction and the fully insulated silicone coating withstands continuous operation from −55°C to 150°C. Type CJ resistors are suitable for commercial equipment using large quantities of components, where compactness, initial cost and low maintenance charges are of prime importance.

Type NJ. These resistors are rated at ⅛ and ¼ W and are, in most respects, similar to the Type CJ. They were designed to meet the needs of the circuit designer who requires a miniature insulated resistor which is expected to show less than 1% change over a three-year period within a normal equipment environment.

Fixed capacitors; trimmer capacitors; inductors; "Fotoceram" printed-circuit boards

These components are part of the unique range manufactured by Corning Glass Works. They have many special properties and full details are given in Product Guide C which is available from Electrosil Ltd. Details concerning the metal oxide film resistors are given in Component Guide R.

Protection for Semiconductor Rectifiers

By G. D. PERKINS, B.A., Dipl.Ing., M.I.E.E.
Belling & Lee Ltd.

Rack built test equipment

The protection of semiconductor rectifiers is a problem which is assuming increasing significance in modern electronics. It is not proposed to discuss here any aspects of circuitry or to delve too deeply into theory, but to give some useful general information for designers. From a large number of observations and laboratory experiments the fact emerges that, although semiconductor rectifiers are extremely reliable, some form of protection against current overloads is highly desirable to avoid expensive damage, and inconvenience.

Characteristics of semiconductor rectifiers

BECAUSE of their small physical size, semiconductor rectifiers, especially silicon diodes, have low thermal capacity. They are very frequently operated at or near maximum current rating, which leaves only a small margin in hand to deal with overloads, even when used in conjunction with a heat sink or cooling fins. It is a well-known fact that the break-down time of these devices is very short. Therefore, if a semiconductor rectifier is to be protected against short circuits, an ordinary fuse or circuit breaker is inadequate, and a special device is needed. This must be able to:

(1) Carry the rated current and yet operate at a small overload, and

(2) Act very rapidly, at any dangerous overload, small or large.

It should be noted that a surge, even of quite short duration, constitutes a dangerous overload.

Such a device, in the form of an extremely fast operating fuselink, has now been developed by "Belling-Lee". This has a reasonable physical size in keeping with the trend of miniaturization.

A little theory

The heat capacity (K) of a body is proportional to its mass and to the specific heat of the material of which it is made. Whilst the specific heat is a material constant, the mass depends on the shape and physical size of the body. To raise its temperature by T°C the total quantity of heat required is:

$$Q=KT \qquad (1)$$

and from this expression it can be seen that the temperature of a body of a given heat capacity is directly proportional to the quantity of heat introduced into it. This heat may be produced in any one of a number of different ways, but if it is done electrically it can be seen that the smaller the heat capacity, the hotter the body will become for a given wattage expenditure.

By the principle of the conservation of energy:

Heat produced = heat stored + heat lost

Heat losses occur in different ways, by convection, by radiation and by heat conduction. If the blowing time of a fuse or the destruction time of a silicon rectifier is sufficiently short, heat losses may be neglected and the heat produced can be equated to the heat stored in the conducting element. This heat is produced by the passage of the current, and can be expressed as follows:

$$Q = I^2rt \qquad (2)$$

where r is the resistance of the device and I is the current passing through it.

From expressions (1) and (2) it can be seen that:

$$I^2t = KT \cdot 1/r \qquad (3)$$

i.e., for a given body of resistance r raised through a temperature of T°, the product I^2t is a constant which depends on the heat capacity of the body. When the current varies, as it does in the practical case with which we are concerned, an integration has to be carried out; nevertheless the value of this integral, commonly known as the current/heat integral, is similarly a constant:

$$\int_{o}^{t} i^2 \, dt = C \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

and the value of C can be determined, e.g., by oscilloscopic measurements.

If we now take the special case where I is the prospective current, I_p, and the time is the virtual time, t_v, it is possible to calculate the blowing time of a fuse. The prospective current is the current that would flow through the fuse or rectifier on the making of the circuit which causes it to blow. (For exact definition see B.S. 2692 para 3.22.) The virtual time of a period of operation of a fuse or of a rectifier is the time for which the prospective current would have to flow to produce the same amount of energy as the actual current does in time t (for a more precise definition see B.S. 2692 para. 3.32). It is given by the expression:

$$t_v = \frac{\int i^2 dt}{I_p^2} = \frac{C}{I_p^2} \ldots\ldots\ldots\ldots\ldots(5)$$

For the very short time intervals we are considering, t_v can be taken as either the operating time of the fuse or the destruction time of the rectifier. Expression (5) clearly shows that for a given prospective current the virtual time depends on the magnitude of C. Consequently C for the fuse should be small to ensure a fast blowing time, and

$$C < C^1$$

where C^1 is the current/heat integral or I^2t value of the rectifier.

One of the ways of defining the limiting condition (i.e. the destruction point) which is commonly used in electronic engineering nowadays is by stating the I^2t value, where I is the prospective current passing through a device (in fact I_p) and t is the time taken for its destruction. Every different kind of device has its own characteristic I^2t value. If it is stated that a device has an I^2t value of 1, this means that a current (I) of 1 A will destroy it in 1 s, and a current of 2 A will take $\frac{1}{4}$ s, and so on.

The difficult requirement to meet is the combination of the property of being able to carry the rated current indefinitely, or for a reasonable length of time, with the ability to blow rapidly at small overloads. These two characteristics are diametrically opposed. Consider for instance the case of a normal service type 1 A fuselink, which has a wire element of diameter 0·0022 in. An increase in its speed of action can be achieved by reducing the wire diameter to, say 0·0018 in., and thus giving it a smaller heat capacity and of course a smaller I^2t value, but it will be found that the fuselink will not then be able to carry its rated current of 1 A continuously. Also, of the fusing factor of such a fuselink is reduced to:

$$a = \frac{I_f}{I_r} = 1{\cdot}25$$

where

I_f = fusing current
I_r = rated current

which is of the order that is required to ensure blowing at small overloads, it will be found that operation becomes unreliable, due to the fact that it lies on the flatter part of the time-current characteristic curve, where small variations of current are accompanied by quite large changes in the operating time.

To overcome the difficulties caused by these conflicting requirements the shape of the time-current characteristic curve must be altered so that the flatter part lies more nearly parallel to the time abscissa, and the portion preceding the knee of the curve is sharper; this necessitates a physical principle which will permit the use of a thin wire, and at the same time will ensure a working life of at least 1,000 h at the rated current. This can be achieved by critically controlled cooling *via* the medium of a heat sink. If a fusing factor of 1·25 is needed the heat sink must be able to dissipate the heat generated at currents of 25% above the normal rated current (I_r).* At greater currents than this the artificial cooling ceases to be adequate and the possibility of attaining cut-out at small overloads has been achieved.

A patent application has been lodged by Belling & Lee Ltd. to safeguard this invention, and fuselinks of this construction were shown at the firm's stand at the R.E.C.M.F. Exhibition under the registered trade name "Minikron". The Minikron is a miniaturized fuse of length $\frac{5}{8}$ in., and diameter $\frac{3}{16}$ in. (standard 00 size), and of the usual tubular construction. It can be used in any type of fuseholder suitable for the "00" size.

The range of Minikron fuselinks mainly for electronic applications contains Types L.1505, L.1506, L1507, L1508. The designation is expressed as a catalogue number rather than by a figure of rating in order to avoid replacements with other types having the same rating and physical size but different characteristics.

In general it can be said that these are suitable for rectifiers with continuous outputs of 720—750 mA, 1 A, 1·5 A, 2·3—2·5 A, respectively, and high p.i.v. The selection of the correct type for a particular application should be made by consulting the characteristic curves.

Test gear

Obviously a number of different tests have to be made on fuses of this kind, necessitating quite complicated gear. However, we will confine ourselves to a general description of one particular piece of equipment. This is rack built (see illustration on title page), and contains two main circuits, one of which (*a*) is for testing rectifiers, and the other (*b*) for the actual "blowing" or fuse operating tests.

Test procedure

The test procedure is as follows:

The rectifier is secured upon the rack by means of conventional terminals, and first tested in circuit (*a*). On the oscilloscope the well-known forward volts/forward current characteristic can be observed. The "blowing" test is then carried out using circuit (*b*) by passing current through the diode which is in series with the protecting fuse. This test should be carried out for each type of diode for several different currents between its rated current I_r and 100 x I_r. After the operating test, circuit (*a*) is switched back and the diode is rechecked to see that it has suffered no harm, which would be revealed by an alteration in the above mentioned characteristic on the oscilloscope.

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* Semiconductor rectifiers will generally withstand currents of 30-35% above their rating without harm.

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NEW BOOKS

Low-frequency Amplifiers

By A. Schure

149 pp. Chapman and Hall Ltd. Price 32s.

THIS BOOK is written for the American reader and the terminology is unfamiliar to us but this does not distract from the general attractiveness of the book. It comprises two parts—Low Frequency Amplifiers and its companion volume—Low Frequency Amplifier Systems.

The tremendous interest in high-fidelity reproduction, both monaural and stereophonic has led to new techniques in amplifiers serving particular ranges, and the book is excellent in its coverage of the circuit components and design of amplifiers in the zero to 100 kc/s range.

The first part describes in detail components, symbols and the principles of low-frequency amplification including a chapter on transistor amplifiers which is particularly helpful to the newcomer to transistors.

The second part extends and further evaluates the problems of the low-frequency spectrum. The mathematics has been kept simple although extensive enough for the interested design engineer to study the theory. This section covers coupling methods, with special reference to the problems of attenuation in the very low and very high frequencies of the range; phase inversion and negative feedback, design of valve amplifiers and transistor amplifier design. The chapter on phase inversion and negative feed back deserves special mention as being a most concise, clearly written and easily understood explanation of these two subjects, which often give so much trouble to students.

In the two parts there are over eighty excellent diagrams and the student will find very useful the many sample problems with detailed solutions given throughout the text.

Both sections have an index which amply list the subjects covered. The print is clear and the production is of a very high standard. The book assumes the reader has a good basic knowledge of radio principles and will make a valuable addition to the library of the advanced student or design engineer specializing in low frequency techniques.

E. A. Larwood

Vacuum Technology Transactions 7th National Symposium

By C. R. Meissner

444 pp. Pergamon Press Ltd. Price 7gns.

THE AMERICAN VACUUM SOCIETY held its Annual Conference for the seventh time last October. The Conference was attended by some thousand engineers and scientists to hear sixty-nine papers. Your reviewer participated in the Conference and had an opportunity to witness the size and enthusiasm of the American Vacuum Society. The wide use and interest in vacuum techniques in America is undoubtedly connected with the vast sums of money spent on the applied sciences, particularly in the fields of electronics, metallurgy and nuclear physics. However, in recent years vacuum engineering has become important in space research for simulating a space environment in the testing of satellites, space propulsion engines and associated instruments. The constant widening of the field of application of vacuum science indicates that whatever emphasis a country puts on its pure and applied research, whether in *medicine* or *space research*, vacuum science will continue to grow rapidly.

The *Transactions* under review are divided into several sections dealing with vacuum components and systems, measuring techniques, metallurgical applications, thin films and gas analysis equipment for partial pressure measurement.

Those concerned with the production and maintenance of vacuum in electronic devices will be particularly interested in the papers dealing with getter-ion pumps. Kornelsen describes a titanium getter-ion pump in which the ionization efficiency is enhanced by using a magnetron electrode system. New developments in the design of Penning-type pumps are also reported and difficulties associated with the pumping of argon have been overcome by the use of novel shaped cathodes and auxiliary electrodes. There are also several papers dealing with the bombardment of surfaces with positive ions as in ion-pumping and cathode sputtering.

The use of getter-ion pumping in place of diffusion pumps for certain applications has created interest in alternative pumping devices to mechanical oil pumps for prepumping. Thus the charcoal sorption pump which was popular at the beginning of this century has been replaced by Varadi and Ettre with a pump using Zeolites (alkali metal alumino-silicates) which are highly sorptive when cooled with liquid nitrogen.

Zeolites have also been used for trapping oil molecules backstreaming from diffusion pumps. Goerz describes a zeolite trap which operates in the range of 10^{-8} to 10^{-9} mm Hg over a period of several months without treatment. Such traps, of course, require thorough degassing before use and are not practical for systems which must be constantly recycled. However *ultra*-high vacuum systems suitable for the latter purpose are described.

Vacuum instruments have been developed with which it is now possible to measure below 10^{-10} mm Hg i.e. the "X" ray limit of the Bayard-Alpert gauge. Adaptations of the magnetron system with either cold or hot cathode electrodes can be used for measurements down to 10^{-14} mm Hg.

The American Vacuum Society is to be congratulated on publishing the *Transactions* so quickly after its Conference. The work will be too expensive for most workers and students and they will have to wait their turn for a library copy. This is a pity because the early publication of the *Transactions* makes available an account of the immediate state of vacuum science in the western part of the world. The writer has advocated before the publication of a cheap soft cover edition and would go further here and suggest that the publishers might consider offering the work to members of scientific bodies at special rates.

L. HOLLAND

Universal Vade-Mecum. Vol. I. Electronic Tubes and Semiconductor Elements

Edited by P. Mikolajczyk.
1213 pp. Pergamon Press Ltd. Price £7.

THIS BOOK was printed in Poland in 1960 by Panstwowe Wydawnictwa Techniczne. The contents of Vol. 1 include diodes, triodes, tetrodes, pentodes, multigrid valves and all their combinations, secondary emission valves, tuning indicators, voltage stabilizers, thyratrons, television picture tubes, booster diodes, rectifying valves, transmitting triodes, tetrodes and pentodes, and semiconductor diodes. Only small transmitting valves and rectifiers are included, the limits being 600 W anode dissipation and 3 A rectified current at a p.i.v. of 20 kV.

Vol. 2, covering transistors, oscilloscopes, photoemissive cells, magnetrons, klystrons, etc., is in preparation.

The explanatory details in the volume are given in seven languages and these are followed by details of the valve sockets, a list of valve manufacturers and their reference coding, together and the index of the valve types and the group number in which they are found.

The next section gives tables of typical characteristics for each group, thus enabling the user to identify the group desired, in such cases where no particular valve type is known.

Finally there are the valve characteristics arranged in 637 groups of identical or similar parameter. Each group has tabulated data for each type in the group, capacitances, a list of equivalents, from 2 to 9 valve curves, outlines and base connections.

The whole appears to be well conceived and expertly done, and the number of errors noted was few. Unfortunately, not all valve types are included—presumably only those which have equivalents were considered to be of sufficient importance. The list of valve manufacturers, however, is undoubtedly the most comprehensive ever published, and includes those in the Soviet Union.

From a check made on a few types, it appears that the information used in the compilation is dated 1959, so that it is now roughly two years out of date. This opportunity is taken of stressing the importance of producing a supplement every two years, and later supplements should incorporate the earlier ones.

F. L. S., A. J. T.

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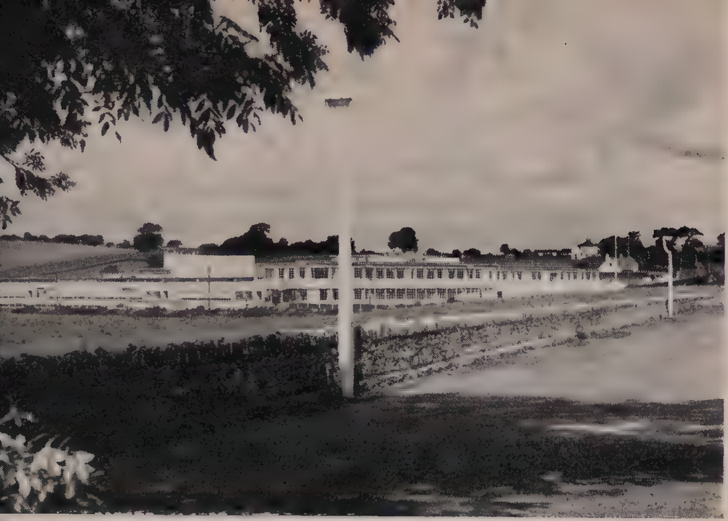


Fig. 1. STC factory at Paignton.

Standard Telephones and Cables Ltd.

Expansion of Valve and Capacitor Divisions

IN the last few years there have been considerable changes in the structure of the Valve and Capacitor Divisions of Standard Telephones and Cables Ltd. Both these Divisions were formerly based at the STC factory at North Woolwich, London with a satellite plant at Treforest in Wales. In 1956, however, the Valve Division was moved to a new factory which had been built in Paignton, Devon and the results were so successful that the Capacitor Division followed some three years later.

The Paignton factory is well situated in a 46 acre site which allows considerable room for future expansion. It was designed to the specific requirements of those who were to be responsible for the manufacturing processes and working conditions at the factory. Most of the basic industrial gases, such as hydrogen and oxygen, are manufactured on site to ensure close control on quality and the factory employs a very comprehensive air-conditioning system which is capable of providing the "ultra-clean" areas required for the manufacture of submerged repeater components.

More than 2,000 people are employed at the factory of which nearly 1,400 are from the Paignton area—the rest of the staff being composed of members of the original Divisions and recruits from other parts of the country. The siting of a large concern in such an area has made a considerable difference to the local "out-of-season" unemployment problem and approximately fifty new workers are now employed each month at the factory.

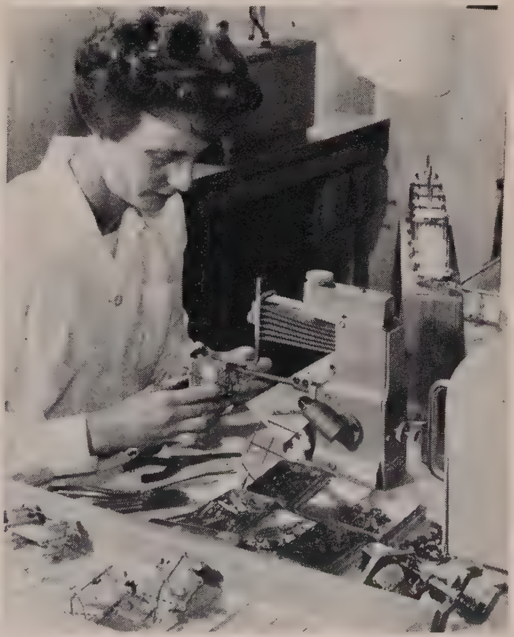
Valve Division

The principal products of the Valve Division are valves for use in telecommunication systems such as microwave radio links and submarine telephone cables, and in the industrial applications of radio frequency heating.

In the past, there has not been a great deal of publicity given to this particular aspect of the wide field covered by the Company. Most of the components manufactured by the Valve Division were designed for use by other divisions and associated companies within the Standard Telephones and Cables Group, and it is only recently that a decision was made to expand the activities of the Division into world markets on a commercial scale.

Standard Telephones has had considerable experience in the manufacture of valves for a great number of years and the range includes rectifiers, thyratrons, low-power valves, high-power transmitting valves and industrial heating valves, microwave valves and pulse modulators,

Fig. 2. Medium power valve assembly.



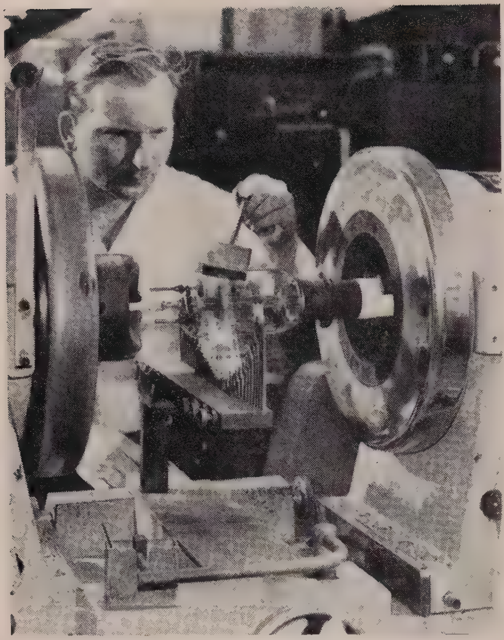


Fig. 3. Sealing-in and annealing of high-power valve.

cold-cathode tubes, vacuum capacitors, lamps, manometers and thermal delay switches.

With respect to microwave communication, the Company pioneered many of the early developments and a great deal of research has since been carried out on travelling-wave tubes, microwave power generators, H-wave oscillators, backward wave oscillators, klystrons and u.h.f. triodes.

It is intended to expand facilities for the production of most of the various valve types and to increase the range of their applications. The recent appointment of Mr. C. H. Foulkes as Valve Division Manager has been followed by an expansion in the sales force, under Mr. G. J. Williams, who is the Commercial Manager.

Capacitor Division

Capacitors, like valves, have been a key product of the Company for many years. Much of the success of this Division has been due to the close co-operation over the years between the capacitor group and the telecommunications systems groups within the Company and this liaison has resulted in the development of many new types of capacitor. Many of the fundamental patents upon which modern paper, mica and electrolytic capacitors were based were registered by the Company.

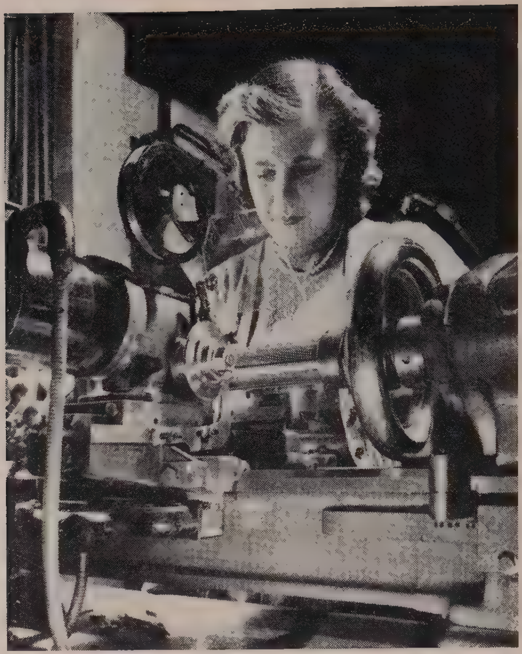
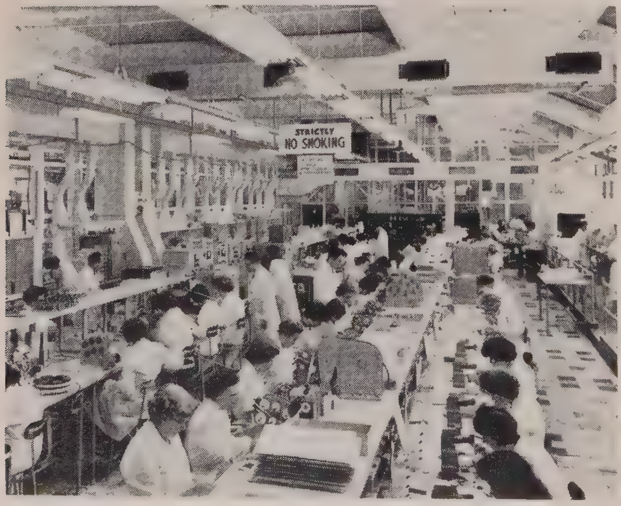


Fig. 4. Grid winding of high power valve.

Fig. 5. General view of tantalum foil shop.



As with valves, the large majority of the capacitors manufactured by Standard Telephones and Cables Ltd. were developed to meet the internal requirements of the Company. Among the more notable achievements of the Capacitor Division are:

(i) "Stantelum" tantalum electrolytic capacitors developed to meet the demand for lower working voltages and smaller physical sizes. Although the characteristics of this particular form of foil capacitor are now generally well known there is a considerable amount of work proceeding at Paignton devoted to the development of the uses of tantalum in this field. Tantalum is an extremely stable material and has by no means outlived its potential. Small-scale laboratory production of, for instance, solid tantalum capacitors is now in progress. The technique was first developed by the Bell Laboratories and described by D. A. McLean in the *Proceedings of the Institution of Radio Engineers*, **44**, p. 872 (1956). It has been the subject of much development, both in Europe and in the United States, and Standard Telephones, as members of the International Telephone and Telegraph Corporation have had the benefit of co-operative applied research from associated houses in both these areas.

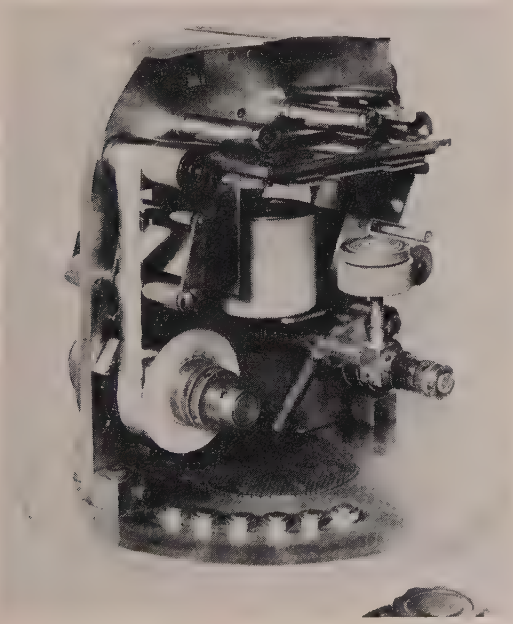
Solid tantalum capacitors are made with high purity tantalum powder sintered to form a cylindrical body of controlled porosity to give a large internal surface. The tantalum pentoxide layer is electrochemically formed over the whole of the internal surface. Contact is made to the layer by a solid manganese dioxide semiconductor which is prepared by a special technique to have a high density and good conductivity. Cathode connection is made over the outside surface of the body by the application of a coat of graphite followed by soldering to the capacitor case. Basically, this type of capacitor has the following advantages:

(*a*) Excellent space factor. These capacitors give up to three times the capacitance for a given rated voltage as compared with the foil type capacitor.
(*b*) Long shelf life. The stability of the oxide layer ensures that the characteristics of these capacitors will be unaffected by long periods of storage.
(*c*) Good low temperature capacitance and power factor characteristics and improved high frequency characteristics.
(*d*) There is no liquid electrolyte to cause leakage or changes of characteristic.
(*e*) Fully hermetic sintered glass seal construction.
(*f*) Temperature range −55°C to +125°C.

Under laboratory conditions, about 1,000 solid tantalum capacitors are made each week but it is hoped to commence full-scale production by the end of September with an initial target of 20,000 per week rising to 60,000 per week. It is envisaged that, within the next two years, the price of the solid tantalum capacitor will have dropped to half that of the foil type.

In the tantalum capacitor range is also included the miniature "Stantelum" capacitor. This was developed to meet the demand for a high quality component of small physical size and having a space factor proportionate to the working voltage. These are housed in tubular silver cases, one end of which is closed, with means provided for welding on an axial lead. The case forms the negative electrode for the capacitor and the construction is such that only polar types are available.

Fig. 6. Experimental aluminium evaporation plant.



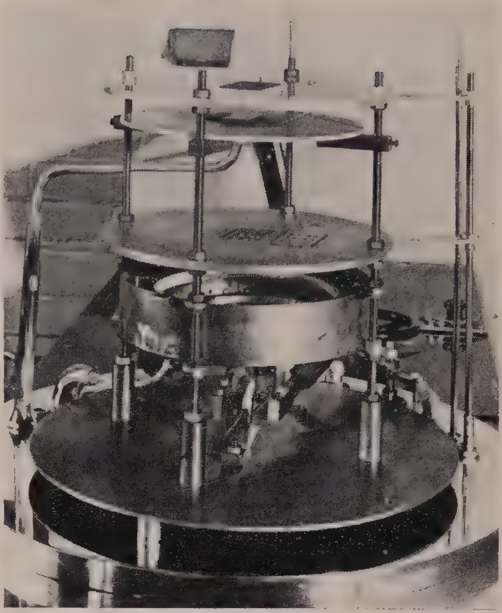


Fig. 7. Sputtered dielectric—general disposition of aluminium source and silicon cathode within the vacuum chamber.

The "Stantelum" foil type of capacitor has been further developed to be capable of operation up to 125°C and to withstand vibration conditions far in excess of those specified in RCS 134B.

(ii) "Stantelac" synthetic dielectric capacitors have good low-voltage d.c. characteristics and also an excellent capacitance-to-volume ratio.

Most conventional capacitors using layers of dielectric material which are self-supporting have good electrical properties but the relationship between capacitance and physical size—the space factor—is poor. Electrolytic capacitors, on the other hand, have a good space factor but only moderate electrical characteristics. Stantelac capacitors represent an entirely new approach to the technique of capacitor manufacturing, employing a dielectric of synthetic organic material which, while still in a liquid state, is applied to a foil electrode. The thickness of this coating can be controlled to a degree hitherto unobtainable in the field of capacitor dielectrics and by controlling the dielectric thickness to suit working voltage the Stantelac capacitor is made with a physical size proportionate to its rated voltage. The present range is down to 50 V and lower voltages are envisaged.

The second electrode is a deposit of fine grain metallizing and the ratings are selected to eliminate the possibility of the self-healing effect during service. They can withstand a voltage surge of at least twice the working voltage without failure.

An outstanding feature of the capacitor is that the insulance remains high over the range of operating temperatures, the average value being in the order of 10,000 ΩF measured at 20°C and remains high at 70°C.

Continued on p. 521

The Component Comparator—

The Key to High-speed Component Testing. Part III

By K. D. Francis, Grad.I.E.E., Grad.Brit.I.R.E.

In an article which appeared on p. 73 of the February, 1961 issue of this Journal, a brief description was given of the new "Component Comparator" and "High-speed Automator" which have been developed by the British Physical Laboratories. The Chief Designer of the Laboratories has now written a much fuller account of the equipment and the first part appeared in our May issue. The second part appeared in June and this final part is concerned with the automatic sorting chute mechanism which has been developed to reduce the functions of the operator by an even greater degree.

THE complete equipment discussed in the first two Parts of this article is capable of testing the majority of components used in the Radio and Electronic Industries at test speeds of up to 6,000 components per hour. Whilst the equipment itself is able to operate at this speed, the operator cannot, in practice, sustain this pace for any length of time. Using a Component Comparator, the High-speed Automator and a jig attachment that has the signal lamp indication adjacent to the test contacts, half the above speed is usually realized. The operators function with this arrangement is to take a component from a bin or feed system, place it upon the test contacts, then act upon the information supplied by the signal lamps, and place the tested component into one of three bins namely "Pass", "High" or "Low" reject relative to the standard component. Therefore, to more nearly realize the maximum speed potential of the measuring equipment, it is necessary either to reduce the actual operation performed by the operator or alternatively, dispense entirely with his or her services.

Because of the diversity of shapes and sizes of the components and the differing types of connectors, the fully automated system that completely dispenses with the operator cannot be sensibly offered commercially, but must be tailored to suit the specialized requirements of the individual component manufacturer.

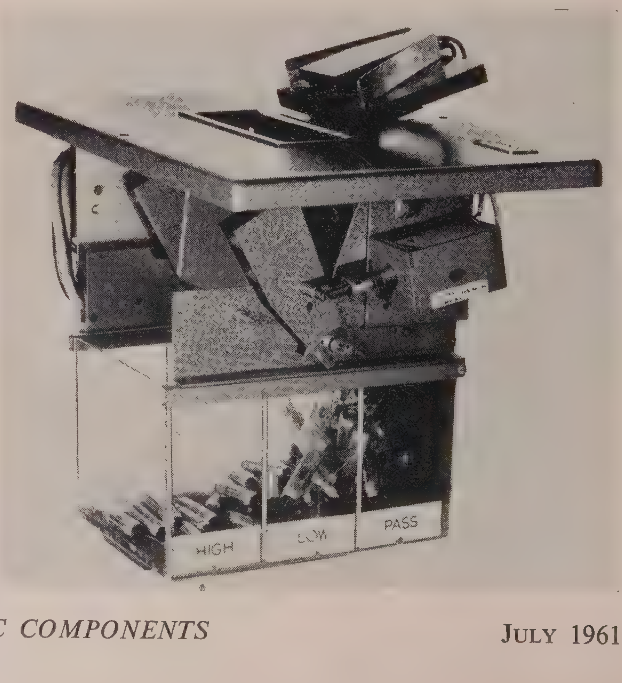
The commercial equipment designer therefore must think in terms of a semi-automated system that reduces the operations performed by the operator to the absolute minimum compatible with retaining the greatest degree of flexibility. To meet this requirement, an automatic sorting chute mechanism has been designed to work in conjunction with the Component Comparator and High-speed Automator.

By employing the sorting mechanism, the operator has only to take the component from the feed system, place it upon the test contacts, and then release the component which falls towards the sorting chutes that have positioned themselves according to the result of the test. The tested component is thus automatically "shot" into the correct bin without any thought or decision on the part of the operative. Using this mechanism, not only has a greater testing speed been realized, but elimination of any errors brought about by acting incorrectly upon information received by the signal lamps, has been achieved.

Operational Description

The sorting chute mechanism is driven by solenoids which are brought into operation by the relay contacts associated with the High-speed Automator. One set of change-over contacts are related to each of the three test conditions. Whilst the component is actually in engagement, the appropriate relay contact is closed and the respective solenoid brings the correct chute into position. A mechanical latch, operated by an auxiliary solenoid, retains the chute in position after the component is disengaged from the test contacts. The action of placing the next component upon the test contacts

The automatic sorting chute mechanism.



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* British Physical Laboratories, Radlett, Hertfordshire.

operates a microswitch which initiates an electrical pulse to drive the auxilliary latching solenoid. This releases the chute from the previous test position enabling it to take up its new position according to the result of the test. The chute is again held into position until the next component is tested.

Principal Design Factors

The problems associated with the design of such a mechanism can broadly be divided into two sections, namely the test contacts and the chute mechanism. **Test contacts.** These are mounted on to a jig which performs two functions—

(*a*) Electrical connection is made to the transformer ratio arm bridge circuit of the Component Comparator.

(*b*) A micro-switch is operated to drive the auxilliary "latching" solenoid when the test component is placed upon the jig.

Whilst the two functions (*a*) and (*b*) each have separate problems they cannot be divorced from each other because in many respects the problems are interelated.

In the present design, the body of the component is placed upon a spring-loaded saddle which operates the microswitch before the connectors of the component are brought into engagement with the test contacts. In this way the component connector leads are in no way distorted as a result of undue mechanical pressure being brought upon them. Difficulties had to be overcome because the spring tension associated with the saddle must be compatible with the electrical requirements of the component connectors and test contacts.

Due consideration was given to ensure that good electrical connection was made to the test contacts irrespective of any configuration that might be adopted by the component leads.

Design was concentrated on making a fairly universal test jig to accommodate the majority of components. It is, unfortunately, inevitable that in specialized cases the jig would have to be tailored to meet the specialist requirement. The existing design is such that an alternative test jig can reasonably easily be accommodated.

Chute Mechanism

One of the chief design factors associated with the sorting chute mechanism was to make any inertia in the mechanical system compatible with the maximum test speed requirement of 6,000 components per hour. This requirement has been satisfied by ensuring that the chute mechanism is mechanically balanced, and by using roller bearings throughout the system in preference to plain bearings.

A further requirement was to keep mechanical noise to an absolute minimum. This is necessary to prevent operator fatigue. All parts that come together during operation have been cushioned, resulting in the inherent noise being considerably attenuated.

In both the design of the High-speed Automator and the Automatic Sorting Mechanism, due consideration was given to the serviceability of the equipment. All electro-mechanical devices have been installed in such a way as to make easy the problem of speedy replacement. Components of this nature have been conservatively used. Assuming the maximum speed potential of the equipment is realized for continuous operation during a forty-hour working week, then the anticipated end of life point for any electro-mechanical component will not be reached during the first year of operation.

Acknowledgments

The author wishes to thank the directors of the British Physical Laboratories for their kind permission to publish this article and to acknowledge the assistance rendered by Dennard Ltd., Aldershot, in the design and development of the Automatic Sorting Mechanism.

Standard Telephones and Cables Ltd.

Expansion of Valve and Capacitor Division

Continued from p. 519

They have an excellent space factor and low effective series resistance at radio frequencies and are suited to transistor circuits. They also have many applications as substitutes for the normal paper and foil capacitors in conventional electronic equipment resulting in a considerable saving of space and a marked improvement in performance.

(iii) Metallized Melinex capacitors use Melinex polyester film as the capacitor dielectric. This material has high electrical and mechanical strength, high capacitance stability and very high insulation resistance. It is capable of operating over a wide temperature range and, with suitable voltage derating, this range of capacitors is suitable for operation from −40°C to +125°C.

(iv) Tubular oil-filled paper capacitors are contained in tubular cases with sintered glass compression-type seals. They have a wide range of application in electronic equipment where high reliability is required at temperatures up to 100°C. A special feature is that the oil filled construction makes the capacitor suitable either for a.c. or d.c. applications, and the design is such that they can withstand severe vibration conditions.

(v) Moulded silvered-mica capacitors have a wide range of applications in the electronic industry, particularly where high-stability capacitors of small size and excellent humidity protection are required. The radial wire types were introduced to meet the latest requirements, particularly for use in printed circuits.

Capacitors are made of mica plates with fired-on silver electrodes. The plates are fully bonded together, and further re-inforced by edge bonding. Terminal wires are securely soldered to the re-inforced area. The capacitors are then moulded in chemically resistant, water impervious thermo-setting resin to give excellent humidity protection.

A SURVEY OF TRANSFORMERS IN THE ELECTRONICS INDUSTRY

Part I. General Classification

By D. R. Adams
Gresham Transformers Ltd.

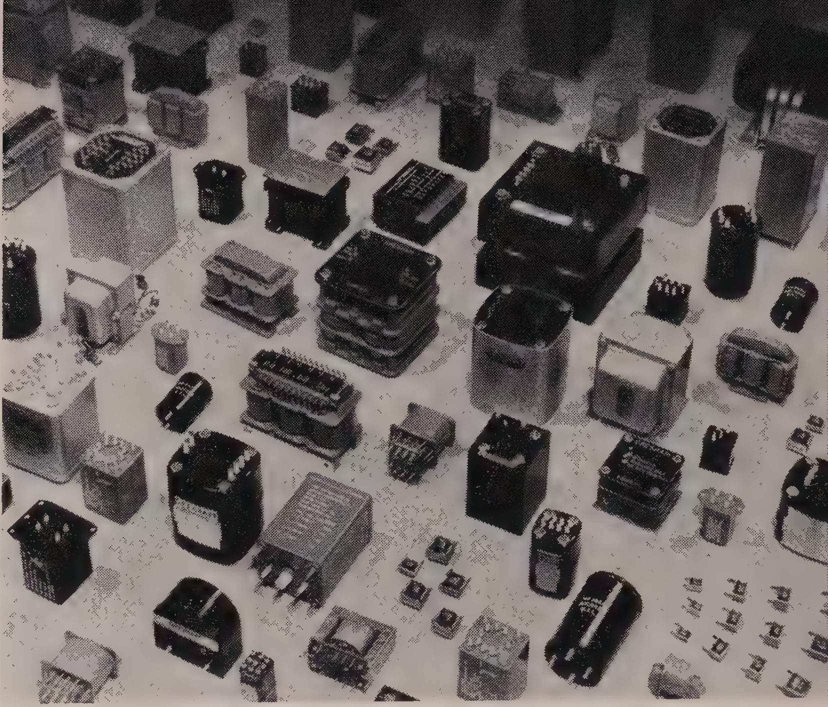


Fig. 1. Some of the many types of small transformers now being used by the Electronics Industry.

There is now generally available a wide range of transformers covering the needs of most users and further types are being developed continuously by the industry for more specialized application. It is the purpose of this article to review the more popular of the designs available and to comment on their suitability for various applications.

The article is divided into three parts as follows:

Part 1. General classification: **Here the various types are considered broadly and comments are made on the factors that must be taken into account before a choice is made for a specific application.**

Part 2. Environmental conditions: **This will deal mainly with the wide variations of environmental conditions encountered in service and the methods used by manufacturers to provide a product having adequate life and reliable performance.**

Part 3. Materials: **The more popular materials in use will be briefly discussed and comments are made on the reasons for their choice. A list of some of the many governing specifications involved is included.**

* * *

Introduction

BASICALLY a transformer consists of a core of suitable magnetic material with the various windings wound and fitted.

Although the core may be made in a number of ways, it usually consists of either laminations (stampings) or the so-called "C" core. This is normally produced by winding a continuous strip of cold-rolled grain-oriented magnetic material on a mandrel, after which it is resin bonded and cut into the two C shaped halves from which the core derives its name, thus enabling advantage to be taken of the superior properties of the material used. This results in a higher efficiency and lower volume and weight when compared with a transformer using laminations.

Transformers made by the two methods are generally called "laminated" transformers and " 'C' core" transformers and these names will be used throughout this article. Other types of cores are mentioned in Part 3—Materials.

Assuming the basic differences, transformers can be generally classified according to use, but the electrical design, construction and materials used may be greatly varied. These factors depend on the environmental conditions to be encountered, together with the degree of reliability required. Thought must also be given to the relative importance of weight, cost, efficiency, regulation, etc.

Reliability is very often a compromise with the other factors, but there are applications when it is of major importance—for example where life may be endangered or great expense incurred by an equipment being out of commission.

An example of the former use is a transformer supplying equipment for use in hospitals where the possibility of dangerous voltages being accidentally applied to the patient must be completely eliminated. An example of the latter case is equipment used on submarine cable repeaters where repair or replacement could entail the lifting of a cable from the sea bed.

Environmental conditions vary enormously in different parts of the world and the effect of these conditions can be varied further by the nature of the equipment embodying the transformer. For example, very high altitudes require large clearances between terminals for potentials as low as a few hundred volts and the transformer will run at a higher temperature due to lack of cooling air. These effects can, however, be minimized if the cabin of the aircraft is pressurized or if other steps are taken to avoid the problem and this information is of vital importance when the type of transformer to be used is being determined.

The effect of the environment on the design is discussed more fully in Part 2.

Where the major consideration is price, it is necessary to arrive at a compromise between the ideal arrangement and that which will provide maximum economy in electrical performance and mechanical arrangement.

High temperature materials are now available and the use of these can result in startling reductions of size and weight. However, it is often not possible to take advantage of this fact on the smaller sizes as regulation and not temperature rise may determine the volume on these transformers. It should also be borne in mind that the smallest transformer is not necessarily the cheapest, in fact the reverse is sometimes the case.

Basic mechanical arrangements available

1. Open type

With this arrangement the core and coil assembly is usually clamped by means of metal frames or directly to the equipment chassis. The coil terminations are made to terminals on a Bakelite board or tag strips on the coil or they take the form of flying leads which are subsequently wired directly to other components in the equipment. This type is suitable for situations where the ultimate user cannot accidentally make contact with, or damage, the terminals or windings. Some of the reasons for specifying open type transformers could be:

1. Where oil is undesirable for various reasons (e.g. fire hazard).
2. To reduce weight.
3. Where the base area is of maximum importance and height is of secondary importance.
4. Where the winding or test voltages are not excessively high.
5. Where stray field from the transformer is not important.
6. Where the environmental conditions will allow (see Parts 2 and 3).

This type of construction can be most economical and has been used on many competitive commercial applications. Depending on the environmental conditions to be met, however, it can prove less economical than some of the alternative types described later.

2. Shrouded type

This is basically the same as type 1 but has the windings protected with enclosures, usually pressings, forming the shrouds and clamps in one piece as shown in the illustration and affords a very inexpensive construction.

This can be used where the transformer is exposed in the equipment. The shrouds then protect the windings from accidental damage and the user from shock. The leads can be made to project downwards through the chassis out of harms way.

This type is not usually recommended for Services use and is generally more suitable for commercial equipment where only normal humidity conditions are met. It should be noted that extreme environmental vibration may fracture the leads if these are not adequately clamped in the equipment.

3. Totally enclosed type

Here the core and coil is totally enclosed in a suitable container often with a removable lid protecting or providing access to the terminals. This type is suitable for many portable or semi-portable applications and can be screwed to the wall or floor and wired in conduit if desired. Another type of enclosure (shown in the illustration) is of an amenity socket outlet transformer developed in co-operation with the Admiralty to withstand the rigorous conditions of Service use.

Totally enclosed transformers are used widely for supplying low-voltage lamps or for use with portable tools; see illustration. In the fully portable construction a robust insulated case is required to withstand a good deal of mechanical abuse. In the case of the transformers of fixed location, as for example the auto transformers used by the Electricity Supply Authority, they may be wired directly into the supply mains and, if necessary, may be sealed against unauthorised interference.

Both the portable and fixed location types may be used indoors or outdoors and the degree of protection provided in each case would be made to suit the conditions of use and this factor may influence the cost.

Variations of this type are in use on airfields sunk in holes in the ground (often waterlogged) supplying lamps for perimeter lighting and traffic control. The degree of sealing required for this application, however, is so good that it may be argued that this falls into the next classification.

4. Hermetically sealed type

The change over point from the totally enclosed type to the hermetically sealed type is not at all definite. This is due to the fact that the degree of sealing provided and the method of achieving the sealing can take many forms. This could vary from a plain drip-proof lid through various gasketed arrangements, enabling the lid to be removed if required, to a completely welded or soldered construction. The gasketed lid arrangement is suitable, for example, on transformer rectifier sets where it may be desirable to open up the unit from time to time during its life.

Today, however, the term "hermetically sealed" as used in the Electronics Industry, is usually taken to mean a transformer either laminated or "C" core mounted inside a metal container, with external terminal connections, which is then sealed with solder. The terminations take the form of metal-to-glass or metal-to-ceramic "seals", usually soldered into the upper portion of the container assembly (examples of this are illustrated). An obvious example is the familiar Joint Service Approved "C" core transformer to RCL.215. This transformer is usually filled with oil which serves the dual purpose of providing a very good insulating filling for high voltages and also provides a means of restricting the temperature rise by conducting the heat generated in the core and coil more directly to the container. Dry air, bituminous compound, silicone oil, wax and other filling media may, of course, be used for certain applications.

On the oil filled type the insulation resistance levels attainable are usually higher than on open types (the insulation is impregnated with oil and not varnish) and higher voltage transformers can be more economically

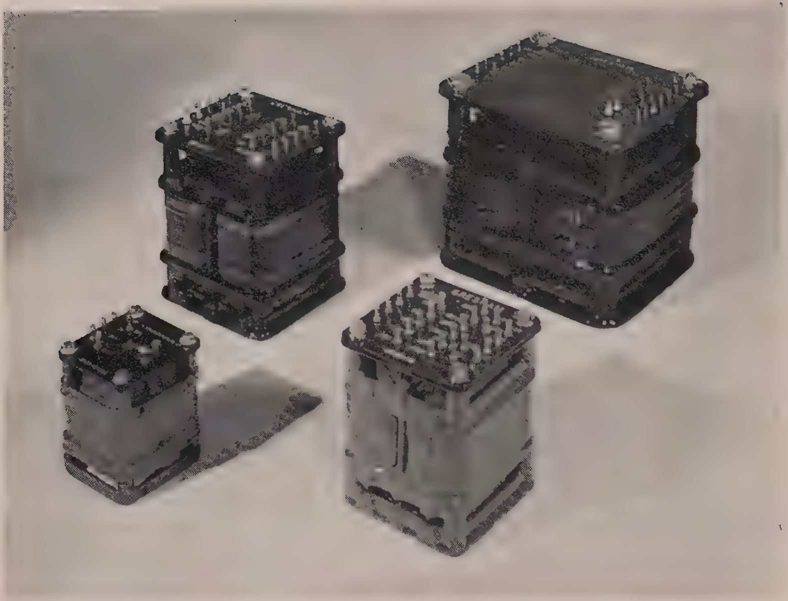


Fig. 2. Open type "C" core transformers for services use, showing windings and cores protected with varnish against moisture ingress.

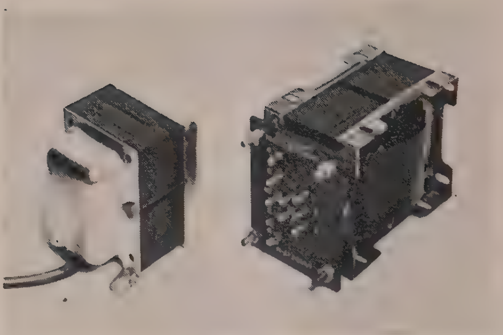


Fig. 5. An open and a shrouded type transformer both for commercial application.

Fig. 3. Open type laminated transformers for Services use with windings and cores protected with varnish against moisture ingress.

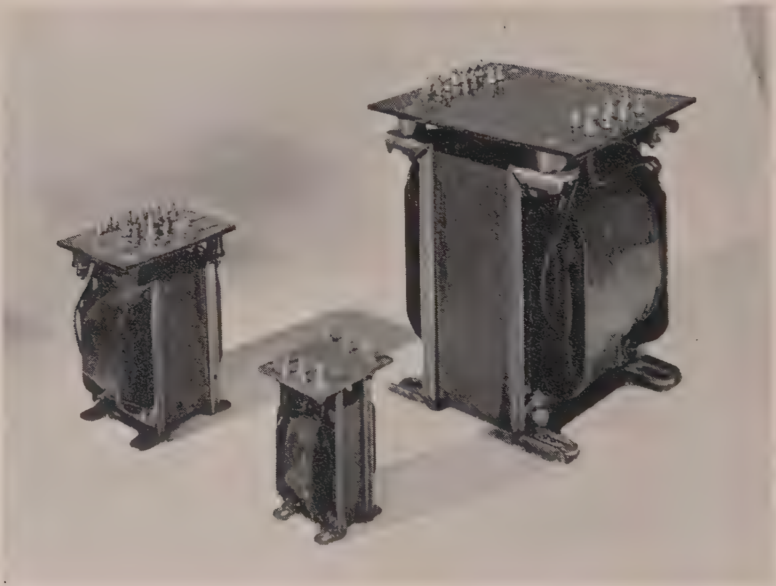


Fig. 6. Examples of totally enclosed transformers for supplying low-voltage lamps or for use with portable tools.

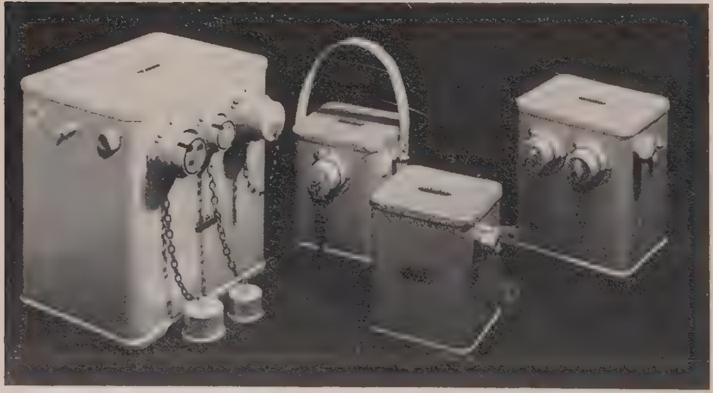
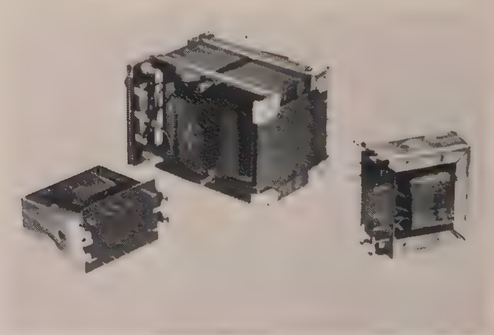


Fig. 4. Open type commercial grade transformers for use with printed circuits.



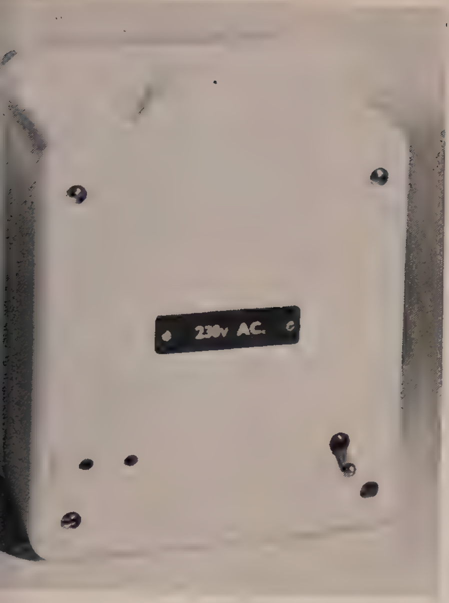


Fig. 7

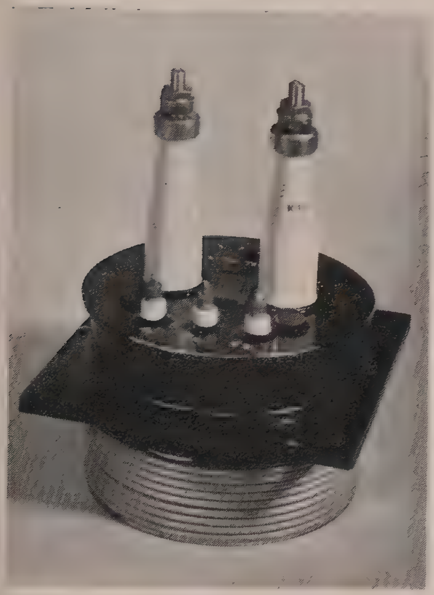


Fig. 10

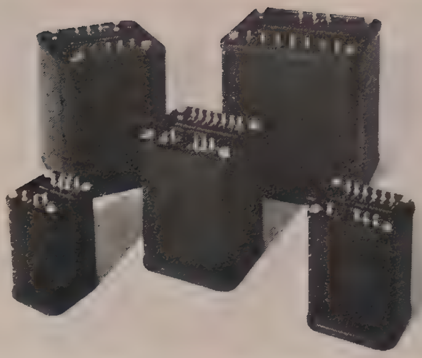


Fig. 8

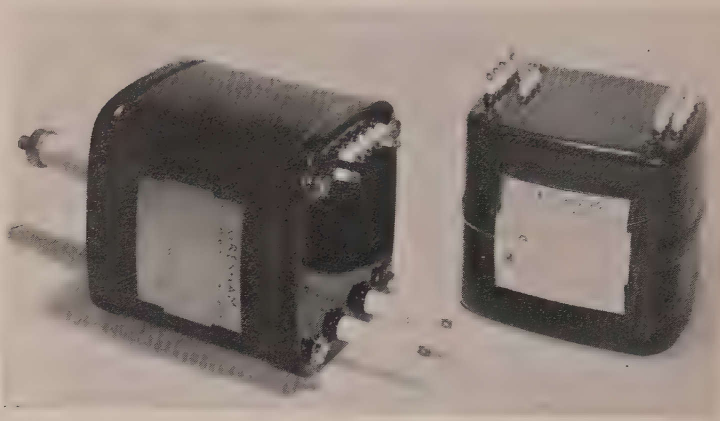


Fig. 9

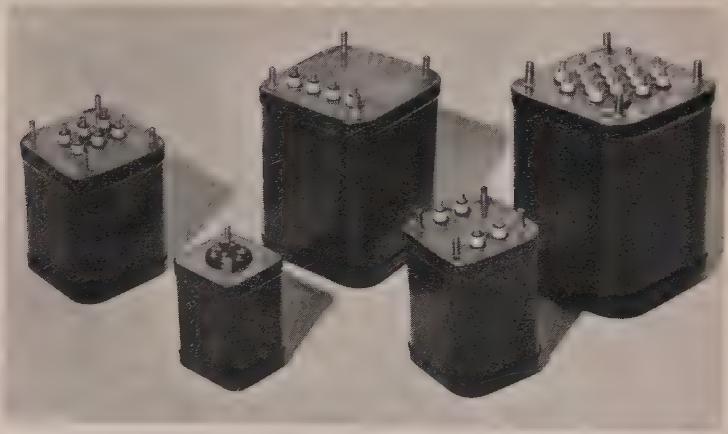


Fig. 11

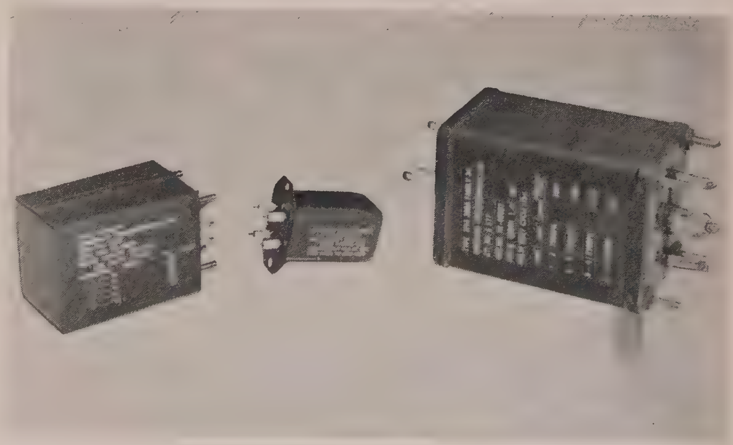


Fig. 12

Fig. 7. A drip proof amenity socket outlet transformer designed to withstand the rigorous conditions of service use on H.M. ships.

Fig. 8. Bitumen filled, Cadet series, transformers with Bakelite terminal boards.

Fig. 9. Oil-filled hermetically-sealed "C" core transformers showing two-part and three-part can assemblies. The "three-part" can has h.t. insulators at both ends.

Fig. 10. High-voltage-hermetically sealed oil-filled transformer using a metal bellows assembly to compensate for oil expansion. This eliminates the need for an internal compressible air bubble.

Fig. 11. American type, bitumen filled, sealed transformers using British components. Terminal sealing is achieved by synthetic rubber washers—cans are soldered.

Fig. 12. American type, oil filled, hermetically sealed transformers using British components.

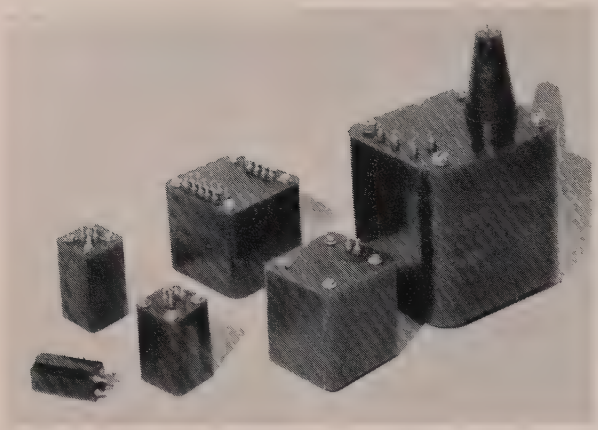
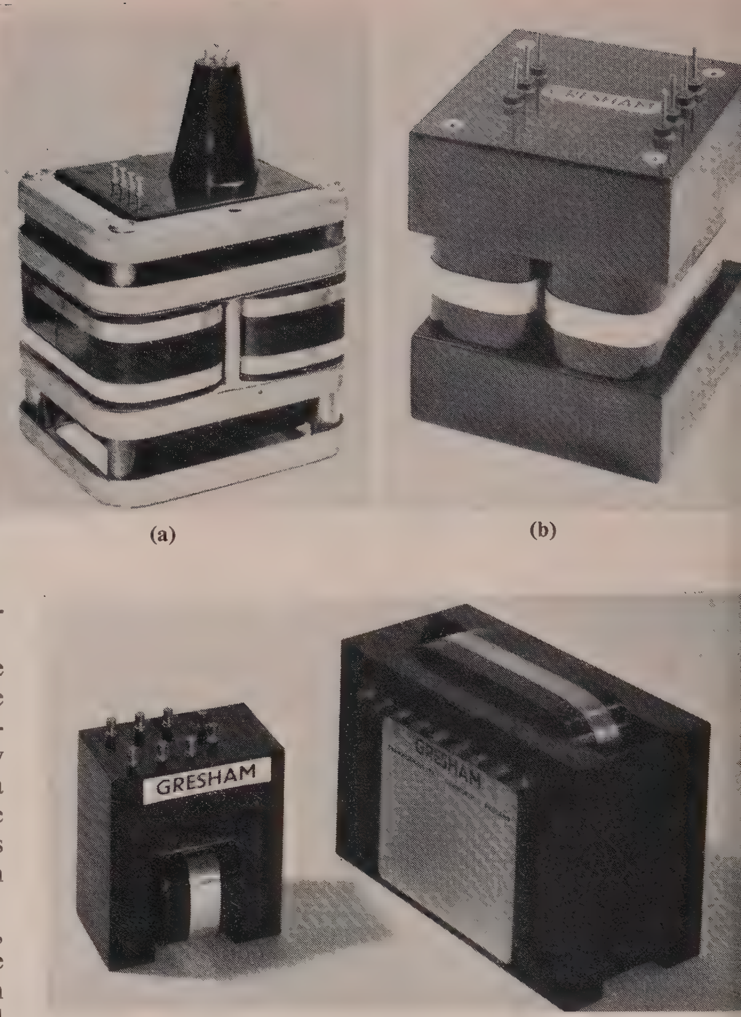


Fig. 13. Resin-cast transformers "cast solid", i.e., with the core and clamps cast integral with the coil.



(a) (b) (c)

Fig. 14. Resin cast transformers with coil only cast. (a) "Vanguard", using conventional frame assembly. (b) "Commander", with fixing centres cast in the resin. (c) "Sepoy", core vertical and in contact with chassis to form heat sink, both single and three phase applications.

produced due to the reduced internal clearances necessary.

One disadvantage the designer must overcome on the hermetically sealed type is the need to provide for the expansion of the oil which takes place as the temperature of the transformer increases. This is usually done by leaving an air bubble within the container to act as a compressible cushion. As this bubble is compressed the internal pressure will rise and at high altitudes this internal pressure will be aggravated by the reduction in pressure of the surrounding air.

If the transformer has to be used in any position, i.e., inverted or mounted at 90° to the horizontal, this bubble will obviously move around, possibly resulting in internal "flash over". These factors must be considered most carefully during the design stage and sometimes result in special "expansion" arrangements having to be made.

On high-voltage units, the use of a metal bellows assembly fitted to the outside of the transformer is sometimes used to provide the necessary compensation for any change in volume due to the expansion of the oil. The need to allow for air bubble effect is thus eliminated. A development of this arrangement is to design the bellows of sufficiently large diameter to form a substantial part of the case (see illustration). A further alternative which provides for expansion is by including within the container a compressible envelope made from oil resisting material filled with air.

5. Resin-cast type

This type is also referred to as potted or encapsulated and various materials are in use for this purpose. This aspect of material does not, however, fall within the scope of this article and is, in any case, more fully covered elsewhere. It should be mentioned, however, that the two most popular materials are polyester and epoxy resin and the latter is generally considered the more suitable of these in the higher quality transformers due to its superior properties. These materials are mentioned further in Part 3. The polyester material is, however, substantially cheaper and is used extensively where conditions will allow.

The main advantages of the resin cast type are:

1. They can be made in any shape and may be "tailored" to fit into an available space.
2. Advantage may be taken of the excellent insulating properties of the "body" of the moulding to reduce the size of, or even eliminate projecting terminals (insulators).
3. There are no "air bubble" problems on high-voltage units.
4. They cannot leak oil.
5. Fire hazards are reduced to a minimum.
6. They are very robust and will often continue to work satisfactorily even when damaged.
7. Winding clearances can be reduced.
8. They have a very good appearance.

Resin cast transformers can be further sub-divided into two types.

A. Cast solid

Here the core and coil, with or without clamps and terminals, is mounted in a mould and liquid resin is poured in, usually under vacuum, to completely enclose and impregnate the windings and core. The resin is then cured with or without heat, depending on the system employed, and the resulting solid block is removed from the mould.

On the larger transformers of this type the fact that the core is cast in the resin can give rise to internal cracking which usually starts from the sharp corners of the core, and this is more serious at very low temperatures. This is caused by the difficulty in matching the expansion coefficients of the resin and the core. Although it is possible to overcome this difficulty in various ways, this factor, together with the cost of the resin, usually makes this construction less popular for larger sizes.

Examples of these transformers are illustrated. They have a very good appearance and unusually good insulation resistance and protection against moisture ingress.

B. Cast coil only with core exposed

In this construction the technique is roughly the same as in (A) above except that the mould is more complicated and encloses the coil only. The core and clamps are then fitted after curing and the whole assembly is protected by a further dip coat of a suitable medium. It should be emphasised that this coating is to protect the core against rusting and one coat only of a normal enveloping varnish is all that is required to comply with most requirements. It is not necessary to coat the moulding, although this is usually done for convenience. The main advantages of this construction are as follows:

1. It is suitable for large transformers where the disadvantages of type A above would apply.
2. Some core materials are "strain sensitive" and the permeability of these materials is often reduced if they are encapsulated in resin. Although it is possible to overcome this undesirable feature in a number of ways, the coil only construction eliminates this possibility entirely.
3. Standard clamp assemblies may be used, thus avoiding the necessity of tooling up special arrangements.
4. These transformers are usually lighter in weight than the equivalent cast solid type.
5. There is usually a reduction in cost over the cast solid version, particularly in the larger sizes, as the amount of expensive resin used is much less.
6. "Heat sinks" may be easily fitted to the core to conduct the heat from the transformer to the chassis (see Part 2, to be published).
7. On small transformers minimum weight can be combined with extremely good environmental protection.

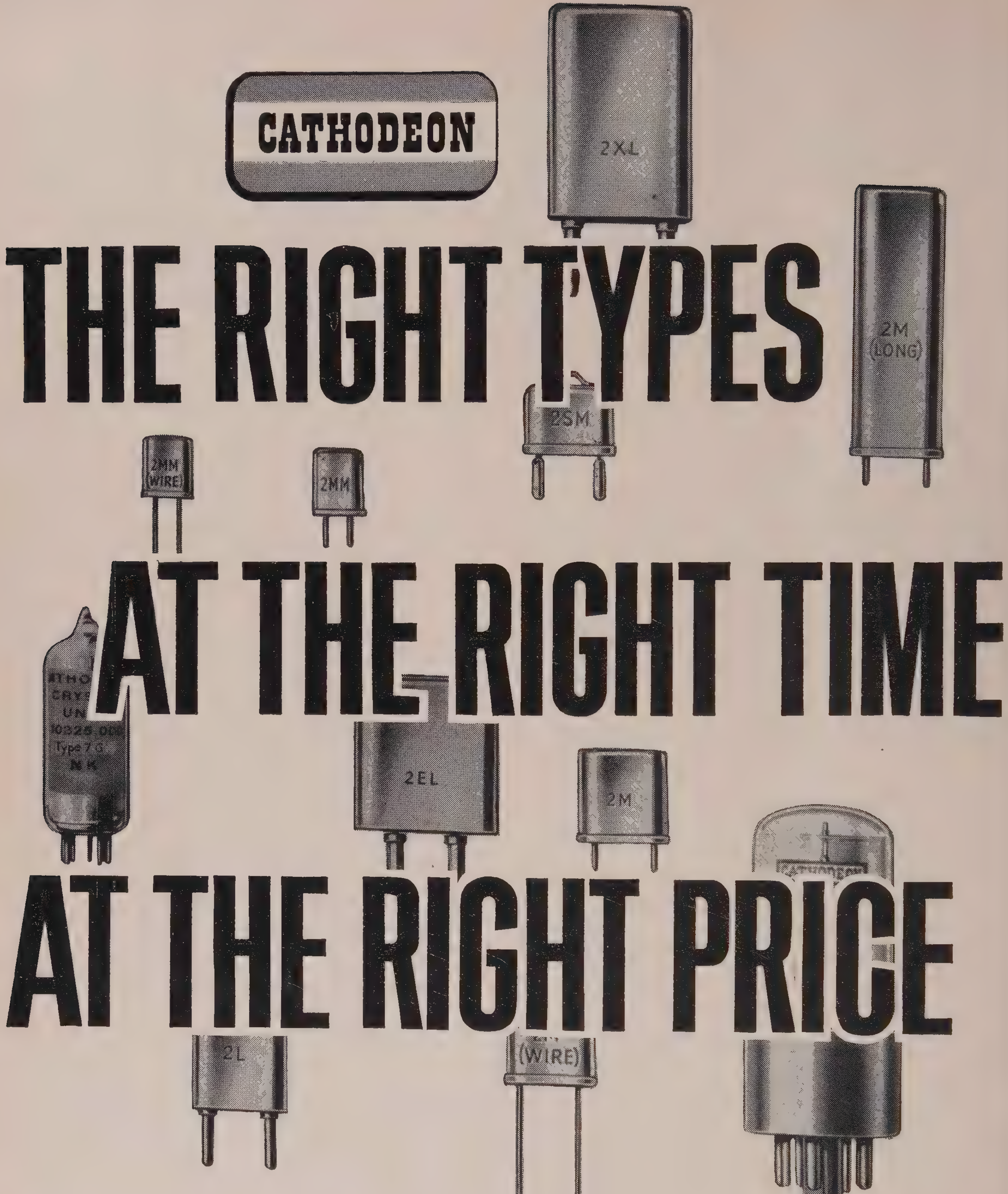
These, then, are the basic types of transformer available, and the following table may help those who have to choose between them.

BASIC TYPES OF TRANSFORMER AVAILABLE

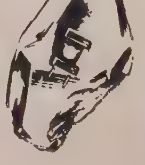
Type	Description	
Open	Economical (can be cheapest of all). Can be made to fit any space. Various terminals and terminal arrangements possible. Wide temperature range possible. Heat sinks can be provided.	Not for very high voltages.
Shrouded	Commercial transformer usually with flying leads. Economical with improved appearance. Protection against electric shock. Not for very damp conditions.	Not for very high voltages.
Totally Enclosed	Unskilled users protected against shock. Portable or fixed location. Can have conduit entry. Can be sealed against unauthorized entry. Can be adapted for almost any environment. Not for light weight applications. Larger in size.	Not for very high voltages.
Hermetically Sealed (Usually oil filled)	Higher voltages possible (available terminals are usually the limitation). Very high insulation resistance. Very long life. The oil may be considered a fire risk. Wide temperature range. Slightly smaller than open types.	—
Resin Cast	Very high voltages possible (terminals can be cast as required). Very high insulation resistances can be obtained. Extremely good for very damp conditions, combined with light weight and small size. Heat sinks can be fitted. Can be made to fit any space.	—

The picture is further complicated by the many core materials and shapes available and this factor, together with other aspects of materials, is considered in Part 2 of this article.

Before leaving Part 1, however, the importance of liaison with the manufacturer as early as possible in the design stage should be stressed. He will often be able to make suggestions resulting in overall savings, and improved design.



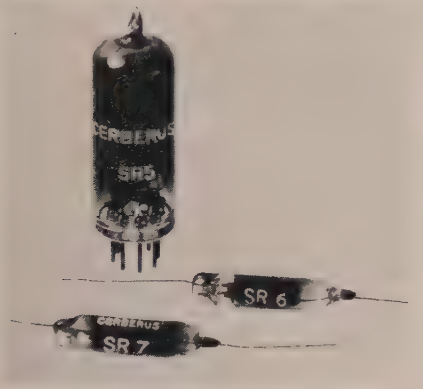
CATHODEON CRYSTALS LIMITED
LINTON CAMBRIDGESHIRE
TELEPHONE LINTON 501 (4 lines)



NEW COMPONENTS

Cold-cathode Reference Tubes

Cerberus A.G. is a Swiss company specializing in cold-cathode valves. In their range of products is a group of precision voltage reference tubes. These are of the molybdenum-cathode type to ensure long operating lives (average life expectation is said to be in excess of 30,000 h). Three types from the Cerberus range are likely to be of interest to equipment designers in this country, and are available from Walmore Electronics Ltd.



Cold-cathode reference tubes.

Type SR5. This is similar to the CV449, 85A2, QS83/3, OG3, but with the added facility of an auxiliary anode. This has the advantage that the main gap can be "fired" with a very small over-voltage.

Types SR6 and SR7. These are subminiature types; the SR6 for 84 V and the SR7 for 104 V. Their small size and double-ended leads make them particularly suited for use in printed circuits.

REC 101 *for further details.*

Television Camera Windings

Direct T.V. Replacements Ltd. is introducing a range of windings suitable for low-priced, closed-circuit cameras. The first component to be released is a deflection coil for use with Vidicon Tubes.

Technical specification:

Frame Winding. 36 A/turn with a d.c. resistance of 110 Ω. The coils require 58 mA peak-to-peak for full deflection.

The frame winding can be inserted directly into the valve circuits without using a coupling transformer but a cancelling d.c. backing-off voltage is required.

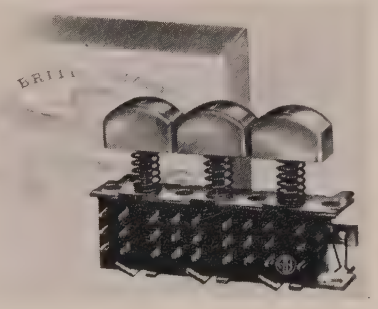
Line winding. 36 A/turn requiring 300 μA peak-to-peak.

The inductance of the winding is 3 mH and d.c. resistance 10 Ω. Both windings are centre tapped, and the coils can be wound to individual specification.

REC 102 *for further details.*

Miniature Push-button Switch

AB Metal Products Ltd. are now manufacturing the Type 500 miniature push-button switch. This miniature assembly is available with 3-pole changeover per button and can be supplied with the number of buttons required up to a 6-way unit; larger units can be produced to special order. The Type 500 is suitable for transistor radio application and remote-control assemblies where space is at a premium, and has applications in many branches of the electronic industry.



Miniature push-button switch.

REC 103 *for further details.*

Airadio Accessories

Marconi's Wireless Telegraph Co. Ltd. has announced the development of two new sub-units to improve the efficiency, reliability and life of the AD 7092 series of airborne automatic direction finders and to reduce the weight and power consumption. One is a transistorized switching unit to replace the vibrator units in the original equipment; the other is an a.c. power unit to replace the existing rotary transformer.

The two modifications are simple to effect and each quite independent of the other.

As the first AD 7092 automatic direction finder was manufactured some 12 years ago, and is now out of production, it may be asked why new units have been introduced at this stage. The answer is that approximately 3,500 of these radio compasses are still giving good service with airlines and air forces all over the world and the new techniques introduced into the two modification units will further increase the efficiency and useful life of the many versions of the AD 7092 which have been produced over the years.

REC 104 *for further details.*

P.D.A. Cathode-ray Tube

The LD603, a new 5-in. instrument tube with features of particular interest, is being prepared for production by the M-O Valve Co. Ltd. The tube, with high-efficiency post-deflection acceleration, has an x-deflection sensitivity of 9·5 V/cm and a y sensitivity of 3·7 V/cm under the following operating conditions:

$V_{a1\ a3}$, 1·5 kV
V_{a4} 10 kV

Post-deflection acceleration of the electron beam in a cathode-ray tube increases trace brightness without incurring the loss of sensitivity that would result from an increase of final anode potential. As existing post-deflection accelerators are not completely efficient, some loss of deflection sensitivity and scanned area occurs. By mounting a mesh about an inch behind the screen this loss is eliminated and the p.d.a.

P.D.A. cathode-ray tube.

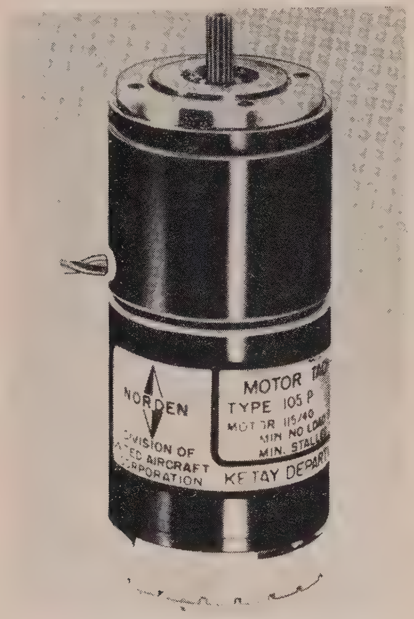
is said to become 100% efficient.

In the LD603, this principle has been employed to produce a tube possessing three times the deflection sensitivity of helical p.d.a. tubes while maintaining a scanned area of 10 × 6 cm. This increase in deflection sensitivity will considerably facilitate the design of wide-band deflection amplifiers. An additional advantage of this method of p.d.a. is its greater freedom from pattern distortion and deflection defocussing. It represents a major step forward in cathode-ray tube technology and will be applicable to future types.

REC 105 *for further details.*

Integrating Tachometer

A size-15 integrating motor tachometer, Type 105P2Y, introduced by the Ketay Department, Norden Division of United Aircraft Corporation, is now available in the United Kingdom through Ketay Ltd.



Integrating tachometer.

Designated Type 105P2Y, this tachometer has high output-to-null voltage ratios and accurate performance over the extended temperature range—55 to 80°C.

Another feature is the instantaneous response attainable since no warm-up time is required at any temperature within the operating range. The unit uses no heating elements, mechanical thermostats, amplifiers or external heat sources and, as a result has the advantages of increased life, low weight and reduced power drain on the overall system.

REC 106 *for further details.*

Transistor Power Supply Sub-unit

The Type 362 transistor power supply, manufactured by Microcell Electronics, is a double unit giving 24 V and 12 V, both isolated independently from earth.

The application of this power unit is aimed at equipments where a high degree of stabilzation is not required.

The general specification is as follows:

	24 V supply	**12 V supply**
Output voltage ...	24 V ±2 V	12 V ±1 V
Output current ...	0 to 1 A	0 to 1 A
Output impedance (d.c. to 20 Kc/s) ...	Less than 0·5 Ω	Less than 0·5 Ω
Ripple (1 A load) ...	Less than 10 mV (p.p.)	Less than 10 mV (p.p.)
Stabilization (1 A load) for a ±10% mains variation	Less than ±4%	Less than ±2%
Max. operating temperature	40°C	40°C
Input voltage	200-250 V 40 to 60 c/s	200-250 V 40 to 60 c/ s

REC 107 *for further details.*

Printed-circuit Resistor for 0·1 and 0·15 Module Grids

As a result of the early development of a new former, the Arcol ERP.1 precision resistor will have a distance between termination centres of 0·3 in. and not 0·4 in. as previously announced.

Manufactured by the Ashburton Resistance Co. Ltd., the ERP.1 has been developed to help overcome the problem of fractured termination leads often encountered when resistors are mounted on printed-circuit boards. Design features include stout 21-gauge tinned copper radial end leads.

The resistor has a tenth-watt rating and is available with tolerances of red, green, yellow and blue (±1, 0·5, 0·25 and 0·1%) respectively.

REC 108 *for further details.*

Zone-refined Tellurium

Johnson Matthey & Co. Ltd. is now producing zone-refined tellurium of high purity. The total metallic impurity content, excluding selenium, is less than 5 p.p.m. and is normally in the region of 1 p.p.m. The selenium content does not exceed 5 p.p.m.

The tellurium is supplied as half-round bar approximately 1 in. × ½ in.

REC 109 *for further details.*

Periglas

The latest addition to the Suflex range of sleeving, Periglas, combines the high mechanical strength of glass with the dielectric properties of p.v.c. The result is a tough thin-walled sleeving with 5 kV minimum breakdown strength and true Class B (130°C) performance, even under conditions of mechanical stress. The material is very flexible, can be pushed back along the conductor without loss of dielectric strength and is available in continuous lengths.

REC 110 *for further details.*

Rare Earth Metals

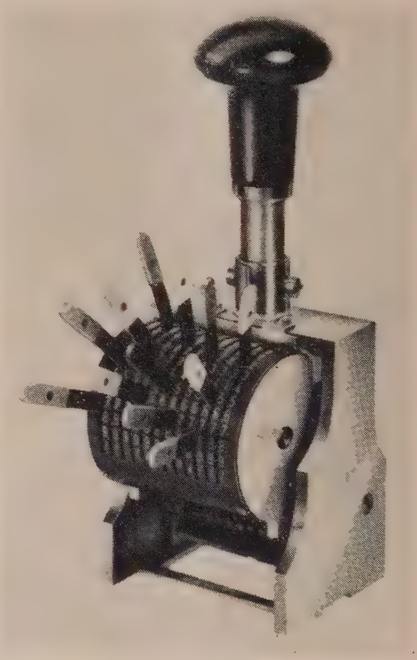
Johnson Matthey & Co. Ltd. is now able to supply scandium, yttrium, and most of the fourteen rare earth metals in sheet form in thicknesses down to 0·001 in. and with a maximum width of 3 in. The sheet is available either cold worked or annealed.

This is the latest development in the Company's production of the metals of this group, which have previously been available as ingots and in some cases as wire of diameters down to 0·02 in.

REC 111 *for further details.*

Coding Machine

The "Dedruma" coding machine, distributed by Westwood Paper Ltd., is suitable for such jobs as marking contents labels, weights, quantities, job cards and envelopes, batch numbers, operators' references, voltage ratings, electrical data, and order numbers on internal forms and files.



Coding machine.

The machine is fitted with colour-capped levers which move smoothly and click positively into position against the required symbol or number on the drum, ensuring ease and accuracy of setting. Once set, the levers cannot be moved accidentally and the complete visibility of the setting helps to eliminate errors.

Hand-operated models are available with from 4 to 12 wheels and, for special applications, models are available with up to 32 wheels. For these larger models a foot-operated stand is recommended. The wheels, in hardened solid brass, can be engraved in clear-face letters, figures, symbols or combinations of code names, in characters from 2 mm. to 8 mm. high.

REC 112 *for further details.*

RADIO & ELECTRONIC COMPONENTS

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Si vous désirez obtenir des renseignements complémentaires sur tout article figurant dans les pages d'annonces ou éditoriales, veuillez inscrire le numéro de référence correspondant dans un des espaces marqués REC sur les cartes ci-contre. Détacher la carte et l'adresser à *Radio and Electronic Components.* Nul affranchissement n'est requis en Grande-Bretagne ou en Irlande du Nord, mais tous nos lecteurs de l'étranger devront affranchir leur carte au tarif habituel.

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July, 1961

RADIO & ELECTRONIC COMPONENTS

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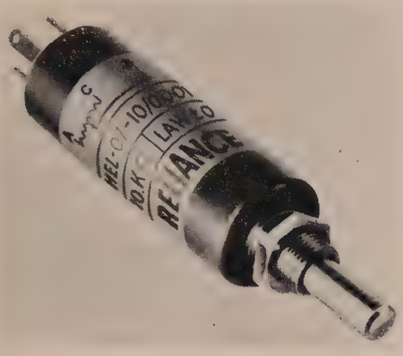
Helical Potentiometers

The Reliance Manufacturing Co. (Southwark) Ltd. has commenced production on the first of a range of helical potentiometers. This new potentiometer—the HEL.07-10—requires 10 turns of the spindle, through 3600°, to cover the full resistance range and it is stated that, due to the unique design and construction, backlash is eliminated and accurate resetting is easily achieved.



Helical potentiometer.

The standard models cover a range of 100—30,000 Ω with a tolerance of ±5% and with the whole element uniformly loaded the rating is 2 W at 20° ambient. Law accuracy figures are absolute and are within ±1·0% on the standard models whilst specials can be supplied to within 0·25% if required.

The overall dimensions are 2 in. long by ¾ in. diam. the whole being housed in an anodised case. Dials for the potentiometers are available.

Additional models to the range are under development and will be for servo application with extremely low torque, ganging and tapping facilities and in synchro sizes 11 and 15.

REC 113 *for further details.*

Universal Klystron Power Supply

Decca Radar Ltd. has developed a versatile instrument designed to provide stabilized power supplies for the majority of low-power klystrons. It has separately monitored independent supplies, each of which is continuously variable over its operating range. Three large meters with clear dual calibrations, each with a press button range selector, allow six supply points to be monitored. The standard arrangement is resonator (beam) supply voltage, resonator current, and reflector voltage normally displayed, and on operation of the press button any combination with the following additional points: heater voltage, heater current and grid voltage.

Universal klystron power supply.

To prevent accidental damage to the valve, and at the same time enable the correct operating potential range to be selected, double limit stops are provided for setting up the controls for the heater, resonator, reflector and grid voltages.

A built-in generator provides square wave and saw tooth modulation with automatic d.c. restoration. Modulation is applied to the reflector electrode, which may also be operated from an external source of modulation through a socket on the front panel. An additional socket is provided to allow the internal modulation to be monitored or provide a trigger pulse for synchronising other equipment.

Conservatively rated components are used to ensure long life and reliability under all conditions of operation. A protection circuit incorporating a thermal delay switch prevents the application of reflector voltage until the heater has had sufficient time to warm up.

As certain klystrons require air cooling, a power supply socket is provided which is wired in parallel with the input supply. The instrument is suitable for use with power input supplies of 110—120 and 200—250 V, 50—60 c/s.

Resonator (beam) supply. With the resonator at earth potential the klystron cathode supply can be adjusted to any voltage between —250 and —3,000 V with a continuously variable control and a fine control for precise adjustment. This voltage, and the klystron cathode current are constantly monitored. A maximum cathode current of 65 mA can be obtained with resonator cathode potentials of up to 750 V, 40 mA from 750 V to 2,000 V and 30 mA from 2,000 V to 3,000 V. The stability is such that a supply voltage change of ±10% will only change the resonator potential by ±0·5 V, while a change of cathode current from zero to full load alters the resonator potential by approximately 1 V. The maximum ripple content under 3 kW—30 mA conditions is 10 mV r.m.s., and considerably less at lower operating potentials.

Reflector supply. A continuously variable negative voltage for applications to the reflector is available with respect to the klystron cathode. This voltage can be adjusted between —20 V and —1,000 V by means of coarse and fine controls, and is constantly monitored. A change of ±10% in the supply voltage produces a reflector potential change of ±100 mV. A reflector current of up to 1 mA can be obtained with a ripple content not exceeding 1 mV r.m.s. There is no interaction between resonator and reflector voltages since completely independent stabilized supplies are provided.

Grid supply. Since some types of klystron require a grid or auxiliary negative voltage with respect to the cathode, this has been provided. The potential can be varied between 0 and —200 V and has the same stability and ripple content as the reflector supply. This voltage can be indicated on one of the meters by operation of a push button.

Heater supply. To prevent modulation and drift troubles due to using unstabilized a.c. for the klystron heater, a stabilized d.c. heater supply has been incorporated in the instrument. The heater voltage can be continuously varied between 3 V and 10 V with a maximum current rating of 1·5 A. Both the heater voltage and current can be monitored on the meters by operating push-button switches. A lock is provided on the heater voltage control to prevent accidental maladjustment and hence damage to the klystron. A change of ±10% in the mains supply voltage will cause a heater voltage change of ±200 mV; the ripple content under maximum power conditions is 10 mV r.m.s.

Modulation. The built-in waveform generators modulate the reflector of the klystron at any amplitude level selected by means of the panel controls. Both coarse and fine controls are provided for varying the square wave modulation between 750 c/s and 3,500 c/s. Waveform amplitude is adjustable between 0 and 120 V. This output is available at the front panel for synchronizing or monitoring purposes.

Saw-tooth modulation is generated at a fixed frequency of 900 c/s and the amplitude is variable between 0 and 200 V. The output is available at a panel socket for monitoring or synchronizing purposes.

REC 114 *for further details.*

Bach-Simpson Test Sets

Aveley Electric Ltd. has introduced into the United Kingdom market two Bach-Simpson test sets, Types 260 and 270.

These meters are a.c.-d.c. multi-range instruments, having 20,000 Ω/V d.c. and 5,000 Ω/V a.c. Although basically identical instruments, Type 270 incorporates an anti-parallax mirrow scale and knife-edge pointer.

The scale layout of these testers have been

Bach-Simpson test sets.

designed for maximum readability and the precision components and special calibration techniques employed ensure accuracies of 1·25% on most d.c. ranges, with similar accuracies on other ranges. This accuracy is maintained by protective features which include circuit fuses, motor-current limiting diodes and spring-loaded jewel movements.

The meters are said to have proved dependable and rugged in operation.

REC 115 *for further details.*

Cold-cathode Thyratron

After a long period of research, a new electronic switching element for high power named the Arcotron has been created by the Cerberus AG, Switzerland.

The characteristics of the Arcotron are similar to those of a thyratron. The suppression of the heater permits an immediate function of the tube when the supply voltage is switched on and makes possible a considerable reduction of the tube dimensions in comparison with thyratrons of equal power.

At present, 3 A Arcotrons for 220, 380 and 500 V∼ as well as a 6 A-type for 380 V∼ are available.

The component is available from Walmore Electronics Ltd.

REC 116 *for further details.*

Miniature Thermal Delay Switch

The Valve Division of Standard Telephones and Cables Ltd., has developed another miniature thermal delay switch to add to their wide range. It has a nominal delay of 10 s at a filament voltage of 6·3 V. First samples are just becoming available. Like others in the range this switch is mounted on a B7G base. The delay time is not seriously affected by change of ambient temperature over the range −35°C to +70°C. This is achieved by using a bi-metal stationary strip which compensates for any movement of the active strip due to change of ambient temperature.

REC 117 *for further details.*

Door Runner Section

Creators Ltd. has produced, after considerable and thorough investigation, a door runner section. This has always been a problem to the furniture industry, but Creators have overcome the difficulty by producing a section which ensures smooth sliding movement together with ease and reliability.

The door track section can be produced in various channel sizes, straight lengths, or pre-formed to fit any particular design of furniture, whether it be for television cabinets, kitchen cabinets, cocktail cabinets or any type of furniture incorporating shutters.

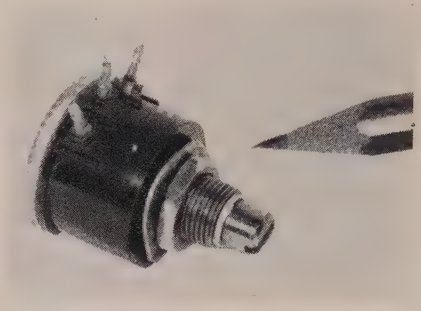
Many of the leading Television manufacturers have already adopted this method.

REC 118 *for further details.*

Miniature Wirewound Control

General Controls Ltd. are now producing a miniature wirewound control that will dissipate 3 W.

The size of this control is 0·916 in. in diam. by 0·660 in. deep, and is fitted with a special silicone glass laminated former, a brass "turned-on" lid, and can either be supplied with turret lugs, solder tags, fly-away connections, or suitable for direct insertion into printed boards.



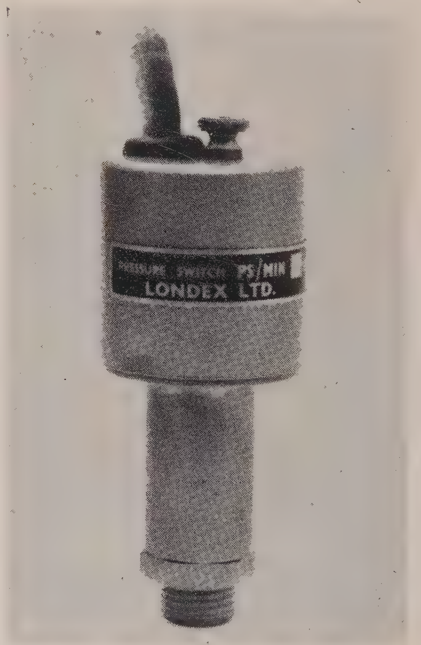
Miniature wirewound control.

The housing is moulded in mica leaded material X4933/4, and can be supplied as a fully-sealed tropicalized unit, with a maximum resistance value of 50,000 Ω.

REC 119 *for further details.*

Miniature Pressure Switch

The Type PS/MIN. miniature pressure switch has been developed by Londex Ltd. as an addition to the wide range of pressure switches described in list 119/J, and is primarily intended for applications where the space available is restricted. In applications where a number of pressure switches are required the PS/MIN enables an economical and neat installation to be made.



Pressure switch.

Although primarily intended for applications where the pressure at which the contacts operate is preset, internal adjustment can be made between the limits of three adjustable ranges which are 10—30, 15—8 and 55—180 p.s.i. The pressure switch is pre-wired and is supplied complete with 4 ft. of 3-core cable. The switches are designed for use with non-corrosive liquids and gases up to a maximum temperature of 100°C. The nett weight is 5 ozs.

REC 120 *for further details.*

High Temperature Masking Tape

Although Paynes Jiffytape Ltd. are able to supply a wide range of high quality paper masking tapes, there has been a long felt need for a material capable of being used in the most modern high temperature applications, such as those involving the use of high bake enamels, epoxy resin based paints and super high temperature processes covered by such specifications as DEF.1059 and others.

Discussions were held recently between members of the company's technical department and the chief metallurgist of one of this country's leading aircraft manufacturers, with the result that a series of tests have been conducted on varying materials. The outcome is a masking laminate which has so far proved completely satisfactory for this type of application.

In producing this material use has been made of the best properties of the Company's P.J.L. release coated paper masking tape, No. 577 and the heat resisting qualities of the adhesive used on their polyester silicone tape. The result is a lamination in which No. 577 P.M.T. is superimposed upon polyester silicone tape.

In production work this material is said to have proved completely efficient, and is being used for operations involving four stovings each of one hour at 200°C. Following such a process it can be removed with ease, leaving absolutely no trace of adhesive residue. In such processes the need to mask the components four times—once for each stoving—is completely eliminated and the whole process is rendered cheaper and more efficient.

REC 121 *for further details.*

Sealectro Components

A new range of Sealectro "Press-fit" one-piece p.t.f.e. insulated stand-offs, terminals, feed-throughs, and turret-type anchor points is announced by the Sealectro Corporation. The range is designed for use in chassis of approximately 0·048 in. thick and provides greater rigidity for assembly convenience and increased equipment reliability.

The new range of "Press-fit" terminals requires a slightly larger mounting hole for the p.t.f.e. body. The metal stud running through the body is of heavier design than normally used. The resulting installation provides far greater mechanical stability for both wiring and component mounting.

REC 122 *for further details.*

ELESTA Components

Britec Ltd. has announced a number of new components from the ELESTA range. These are as follows:

Decade counter selector tube EZ.10B. Further development of the decade counter tube EZ.10A and of the counting principle with single pulses has resulted in the decade counter tube EZ.10B. The new model EZ. 10B can be used for counting speeds up to 1 Mc/s. Just as important in practice is its extremely long operating life even when the discharge remains permanently on the same cathode. The visual indication by the bluish light of the gas discharge of the EZ.10B is however somewhat weaker than that of the EZ.10A.

During 1960 the EZ.10B was available as a development model. At the beginning of 1961 this tube, with slight modifications, became available as the normal production model. It represents a decisive advance in the field of gas-filled counter tubes.

REC 123 *for further details.*

Electronic timers ZS.11 and ZS.14. Electronic timers ZS.11 and ZS.14 are used to delay the operation of output relay contacts, or as timers to operate an input or output circuit at a predetermined interval by retarding each leading half-cycle of the anode voltage after each non-conducting period. To control welding, to regulate time-exposure, or as automatic re-cycling timers, and generally in all kinds of automatic controls.

With the ZS.11, the timing capacitor is charged through pre-selected resistors to give delay times up to 120 s. A voltage stabilizer is incorporated to eliminate interference from mains fluctuations.

With the ZS.14, the controlling resistors are replaced by an ionization chamber to ensure far longer delay times, and as this is unaffected by mains voltage fluctuations no voltage stabilizer is needed.

The only electro-magnetic component used is a compact relay with a contact rating of 1,300 W. The timers incorporate ELESTA cold-cathode tubes, with practically unlimited working life, and other components of equal quality ensuring a high degree of accuracy to very brief delay times. The timers are always ready for immediate operation without stand-by or warming-up delay. Several can be combined for programme control for periodic or aperiodic operation. Complete programme controllers in large housing, incorporating several timers, are available to special order.

REC 124 *for further details.*

Electronic timer ZS.15. Electronic timer ZS.15 incorporates two electronic delay-action stages whose timing periods can be set independently of each other, as well as a mains rectifier and a stabilizer for voltage reference. The apparatus is used also as a re-cycling timer with separately adjustable impulse and internal durations, or as a twin-stage interval timer for aperiodic operation.

ELESTA cold-cathode tubes and its other precision components are used in this apparatus which is said to be very reliable and accurate. It has a high impulse rate, is always ready for immediate operation without requiring preheating time and is unaffected by climatic conditions or vibrations.

The equipment can be used as a timer for conveyor belt or transport installations; as a control for pneumatic tools and machines, and for signal installations, presses, welding machines, etc.; as a thermostat to switch circuits on and off; as a control for chemical and measuring installations, for medical apparatus (artificial heart pulser or for artificial respiration), and so on.

REC 125 *for further details.*

Automatic light control DS.20B. Control DS.20B is a light-sensitive apparatus for the automatic control of illumination; it will switch on directly any lighting installation up to 1,300 VA at any desired degree of ambient illumination. It is suitable to control the illumination of streets, shop window displays, advertizing signs, signal lamps, and indoor lighting installations of all kinds. The combination of a photoresistor and of an ELESTA cold-cathode tube for a.c. operation results in an extremely simple circuit.

A special delay-action circuit is incorporated which prevents unwanted triggering by brief fluctuations of the ambient light.

REC 126 *for further details.*

Automatic light control DS.12. Control DS.12 is suitable for regulating automatically the ambient illumination of all kinds of lighting installations.

A high accuracy and long working life are ensured due to the use of a high vacuum photocell in a patented circuit incorporating ELESTA cold cathode tubes and carefully selected components. A delay-action circuit counteracts the interference caused by brief fluctuations in ambient illumination such as lightning or car lights.

REC 127 *for further details.*

Automatic light control DS.11.D. Control DS.11.D is a photo-electric apparatus which controls automatically the illumination in streets and other places. It will switch on directly any lighting installation up to 1,200 VA at any desired degree of ambient illumination; an intermediate relay, suitably rated, should be used for larger loads.

Its main feature is an automatic sensitivity compensating circuit consisting of a time switch with a synchronous motor which sets the control automatically during the night for reduced sensitivity for morning operation, since the human eye is more sensitive to light in the morning and requires less illumination than in the evening. During the day the control is re-set automatically for higher sensitivity for evening operation.

The control incorporates a high-vacuum photocell, two ELESTA cold cathode tubes, with very long working life, used in a multivibrator circuit, a rectifier and a voltage stabilizer to rectify and stabilize Mains fluctuations, and a delayed action output relay which counteracts any interference due to brief fluctuations in ambient illumination.

REC 128 *for further details.*

RCA Components

A considerable number of new RCA components are now available from RCA Great Britain Ltd. These are as follows:

Silicon diffused-junction rectifiers. These are the Types 1N3193, 3194, 3195 and 3196. They are contained in tubular metal cases with axial leads—the same form as conventional resistors and capacitors. The cases are 0·405 in. long and 0·240 in. in diam. and feature a single glass-to-metal hermetic seal. There is no derating for operating at ambient temperatures up to 75°C and the rectifiers have p.i.v. ratings from 200 to 800 V. Forward currents are up to 750 mA and their structure is rugged and compact.

REC 129 *for further details.*

Germanium *p-n-p* switching transistors. These are the Types 2N414 and 1450 and they are designed for switching applications in industrial and military data-processing systems. The 414 is an alloy-junction type for medium-speed switching applications having a high collector-current rating of 400 mA and a maximum dissipation of 150 mW; the 1450 is a drift-field type for non-saturating high-speed switching applications with switching times of 100 mμs max. (turn-on) and 85 mμs max. (turn-off).

REC 130 *for further details.*

20-A silicon rectifiers. Fourteen new industrial rectifiers have been introduced to replace all corresponding prototypes and are designed to provide superior performance in critical power-supply applications. The following are the type numbers: 1N248-C, 1N249-C, 1N250-C, 1N1195-A, 1N1196-A, 1N1197-A. Reverse polarity versions are indicated by prefixing the last letter of each type number by the letter R.

REC 131 *for further details.*

Silicon power transistors. These new low-cost silicon power transistors are of the diffused-junction type and are designated Types 2N1700, 1701, 1702 and 1703. They are especially useful in d.c.—d.c. converter, inverter, chopper, voltage-and-current regulator, d.c. amplifier, servo amplifier, power oscillator, and relay-actuator circuits. The transistors are capable of operating at case and/or mounting-flange temperatures from −65° to +200°C.

REC 132 *for further details.*

Beam power tubes. Types 6GW6, 12GW6 and 17GW6 are beam power tubes of the glass-octal type which have been designed for use as horizontal-deflection circuits of television receivers.

REC 133 *for further details.*

Conduction-cooled cermolox tubes. The Types 7801 and 7870 are very small conduction-cooled u.h.f. cermolox tubes which have been designed for a wide variety of applications in which small size and compactness of equipment is of the utmost importance. The tubes may be used as r.f. power amplifiers and oscillators or as voltage regulators where, again, space is at a premium. The 7801 operate at 12·6 V/0·5 A and the 7870 operates at 6·3 V/1·0 A. At 3,000 Mc/s the tubes can provide 3·2 W of c.w. power output with 1 W of driver power output or they can provide a gain of 9 dB with 50 mW of driver power output. A wide gold-plated-copper cylindrical-plate terminal provides high electrical and thermal conductivity.

REC 134 *for further details.*

200°C silicon power transistors. The Types 2N1768 and 1769 are 40 W *n-p-n* silicon mesa transistors and have been designed for applications such as d.c.-to-d.c. converters, inverters, choppers, voltage-and-current regulators, d.c. and servo amplifiers, and relay actuating circuits. They have low thermal and saturation resistance and very good performance at high temperatures.

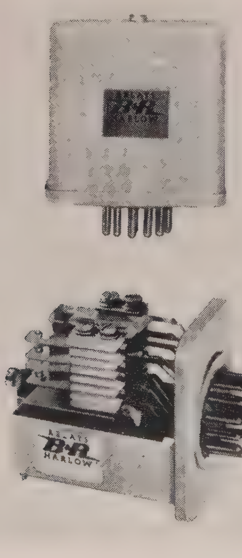
REC 135 *for further details.*

Protected Plug-in Relays

Following the increased demand for plug-in versions of relays, B. & R. Relays Ltd. have recently developed two modified versions of their standard M01 and M51 models. The M01/P which is the d.c. operated type and the M51/P which is its a.c. counterpart, are fitted with a protective cover for use in dust or particle laden air. The M01/PS and M51/PS are fitted with hermetically-sealed covers, which is of particular interest where heavily polluted atmospheres are experienced, such as corrosive acid fumes. Both these relays have obvious applications in control systems for chemical and textile processes, together with many other industries where air cannot in all instances be kept clean. All four relays are mounted on Octal-type plugs with 8—14 pins, depending on contact requirements. These types measure some 2½ in. high, by about 1½ × 2¼ in. across. The weight is 3 oz.

REC 136 *for further details.*

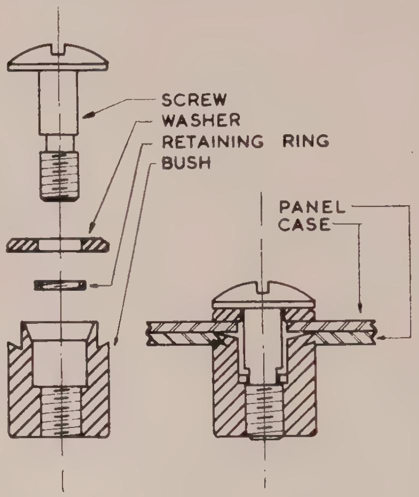
Protected plug-in relays.



Captive Panel Fasteners

An addition to the range of panel fasteners manufactured by Automa Engineering Ltd., is a mushroom-head captive panel screw. As with the standard knurled head type they are made in three sizes. Stock screws are of steel, chrome with polished head, but other materials and finishes can be supplied to special order.

As will be seen in the illustration, four components are involved. The bush is flanged into a countersunk hole in the case. The screw is inserted into an oversize hole in the panel and locked into place with the retaining ring which is screwed over the threaded portion to rest in the groove provided.



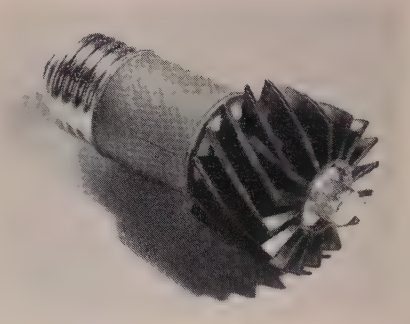
Captive panel fastener assembly.

Easy alignment is assured, regardless of the number of fixing screws used. This is because the screw "floats" in the panel. The washer under the head protects the panel from scratches. No special tools are required for assembly, which is quick and easy.

REC 137 *for further details.*

High-voltage Ceramic-envelope Rectifiers

The latest developments in high-voltage vacuum ceramic-envelope rectifiers from the Dundee factory of Ferranti Ltd. include the UR.41 high-voltage rectifier and the DXV. 18432 experimental high-voltage rectifier. Both these valves have indirectly heated cathodes, which are substantially metallic in nature, and combine the features of conventional oxide-coated cathodes, which are economical in heating power, with that of thoriated tungsten cathodes, which have the ability to withstand high voltages.



UR.41 high-voltage vacuum ceramic-envelope.

The UR.41 was developed primarily for use as an inverse diode in radar modulators, whenever conditions of extreme environments or high peak inverse voltages prevent the use of conventional glass valves. Rated at 16 kV p.i.v., the UR.41 can withstand a surge voltage of up to 20 kV. It will operate successfully at high ambient temperatures, with a limiting anode temperature of 225°C, and has a life of 1,000 hours at this temperature. Maximum peak pulse anode current rating is 14 A, and maximum anode dissipation is 40 W. The UR.41 has an overall length of 105 mm and a diameter over the cooler of 40 mm.

The DXV.18432 is designed for use as an inverse diode in high power radar modulators, and is rated at 28 kV p.i.v., and 30 A peak pulse anode current. Air cooled and liquid cooled versions, with either a Goliath Edison screw base or with flying leads, have been designed. The overall length is 7¼ in., and without a cooler its maximum diameter is 1⅝ in. The maximum diameter when fitted with air cooling is 2½ in.

REC 138 *for further details.*

"Sealectoboards" with Semi-automatic Programming

Pre-punchable masks are the latest introduction to the "Sealectoboard" system of cordless programming. Fabricated from thin, tough, dimensionally stable material, the masks are furnished to register with any size or style of "Sealectoboard".

In operation, the programme is set up on the patching-mask by punching holes where pins are to be plugged—a spring type punch is available to facilitate this pre-programming—the actual patching can then be performed by unskilled operators with the minimum error hazard.

A matt surface on the masks permits the recording of programme details. They can also serve as programme storage because they can be filed for further use.

REC 139 *for further details.*

Miniature Loudspeakers

Two new 2¼ in. moving-coil loudspeakers have just been put into production by Fane Acoustics Ltd. While primarily designed for sub-miniature radio receivers, these units will handle considerable power and can be used for many applications where space is severely limited.

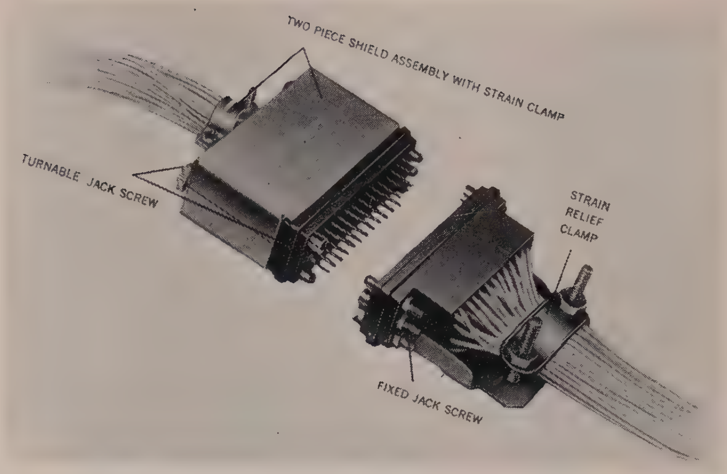
Model No. 220 has the conventional arrangement of cone and magnet assembly and measures 2·165 in. diam. and 0·84 in. in height. The magnet cup is ⅞ in. in diameter.

Model No. 210 has an inverted cone. This results in a reduction in overall height to 0·68 in. Other dimensions are the same as for the conventional model. This unit can be used wherever it is possible to accommodate the slight protruberance of the cone in the thickness of the case.

Both these units are designed around a high-performance semi-columnar Alcomax III magnet which provides a flux density of 8,000 gauss in the air gap. This is said to result in a higher sensitivity than has been achieved in a speaker of this size hitherto.

By the use of new materials for the cone and suspension it has been possible to reduce the main resonance to 350 c/s while still being able to offer a variety of response characteristics to suit different requirements. Either unit can be wound for any impedance in the range 8 to 80 Ω.

REC 140 *for further details.*



Two piece shield assembly with strain clamp.

Crimpable Plugs and Sockets

Aircraft Marine Products (GB) Ltd. has introduced into Europe a range of crimpable plugs and sockets. The housings are manufactured from either phenolic or diallyl phthalate and are available in 14, 20, 21, 26, 34, 41, 50, 75 and 104 positions. The contacts have a gold-over-nickel finish and are designed for crimping either with an automatic machine or a hand tool. When the automatic machine is used application rates of over 1,000 per hour can be achieved. After crimping, the contact is "snapped in" to the mouldings. The contacts are easily inserted and extracted, which are invaluable features on prototype equipment. Catalogues are available on the complete range.

REC 141 *for further details.*

NEW MISSILE COMPONENT PROCESS

A NEW type of minute electronic component developed by Short Brothers & Harland Ltd. for use in the guidance system of the Seacat guided missile incorporates what is claimed to be a unique metal film deposition process which is to be used under licence by Miniature Electronic Components Ltd. of Woking.

This component, a metal film potentiometer forming part of a cordite-driven displacement gyroscope, is said to give better performance than conventional instruments of its type.

The normal potentiometer is similar to the variable resistance used for tuning an ordinary radio set. It consists basically of a length of fine wire through which flows an electric current. The length of the wire, and consequently its resistance, are varied by use of a "wiper" which slides along the wire and "picks off" the current at any desired position.

This conventional type of potentiometer was found unsuitable for the high degree of miniaturization required in the Seacat missile. This is mainly because there are limits to the fineness of a resistance wire, and since the resistance wire is usually coiled, the wiper passing along it must proceed in a series of "jumps"; thus the wire can be tapped only at a series of given points.

To overcome these problems, Shorts Precision Engineering Division developed a potentiometer in which the resistance wire is replaced by a very fine film of metal. This film is less than one-millionth of an inch in thickness and is deposited on a special high-temperature ceramic by an original high-vacuum technique.

The process takes place in a chamber from which the air has been pumped out until its interior has a degree of vacuity approaching that of interplanetary space. The ceramic to be coated is positioned at the top of the chamber and is suitably masked to cover areas on which no film is required. A small piece of metal—usually nickel chromium—is placed on a heating coil and vapourized at a temperature of about 2,500°C. The cloud of metallic vapour rises and condenses on the exposed areas of ceramic in the form of a thin, perfectly smooth film.

The film gives great resistance to the passage of electricity because of its extreme thinness and thus permits the manufacture of very small potentiometers. The metal film potentiometer also possess "infinite resolution", since the wiper touches all points along the length of the resistance in a perfectly smooth progression. In missile servo mechanisms, where the full travel of the wiper may be only a small fraction of an inch, infinite resolution is of great value.

Miniature Electronic Components Ltd. is also manufacturing high quality and reliability multi-turn and single-turn miniature potentiometers and miniature precision resistors under licence from three American companies.

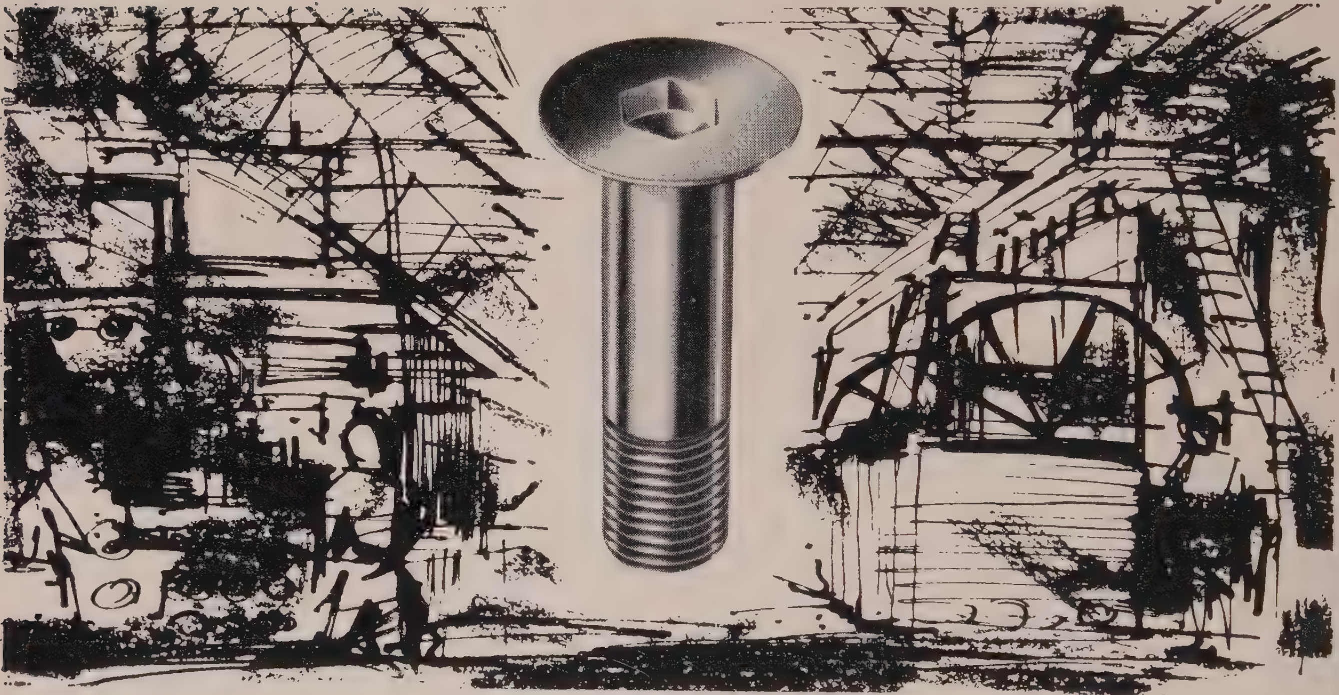
REC **39** for further information

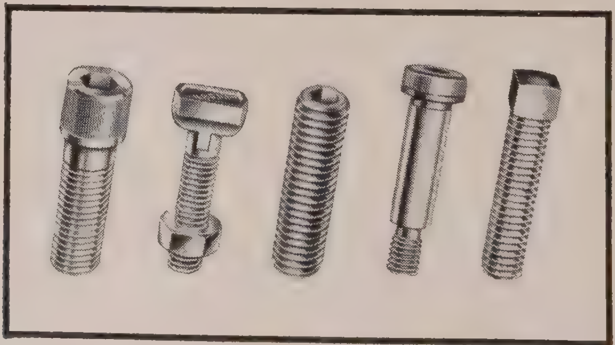
The screws with the fourth dimension

Any screw can present a faultless appearance. It can be measured optically, microscopically, scientifically, yet the vital dimension escapes physical detection.

That dimension is in-built performance. A basic characteristic of Unbrako screws which is proved by a negative. The fact that Unbrako screws do NOT fail industry even when subjected to the most prolonged of gruelling conditions.

Reliability stems from research. No screw in the whole wide world is backed by more research than Unbrako.





Unbrako high-performance countersunk screws are made in a vast range of sizes and threads to cover every need.
A descriptive brochure is yours for the asking.

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ACTIVITIES in the Industry

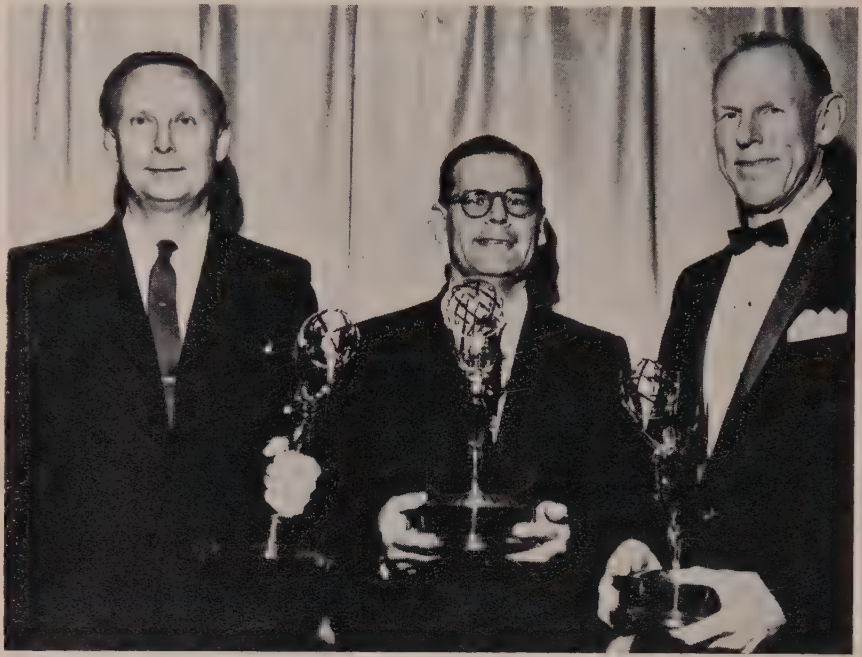
Premier American Award to British Electronics Companies

Marconi's Wireless Telegraph Co. Ltd. and the English Electric Valve Co. Ltd., associated companies within the English Electric Group, have been accorded the honour of jointly sharing this year's engineering award of the National Academy of Television Arts and Sciences with the Radio Corporation of America. The award, which is in recognition of the independent development of the 4½ in. image orthicon camera and pick-up tube, is one of the premier honours which America can bestow in the field of electronics.

The 4½ in. image orthicon pick-up tube was originally experimentally developed by Mr. Otto H. Schade for laboratory use by RCA but not commercially exploited. In 1950 Mr. G. E. Partington, now Chief Engineer of Marconi's Broadcasting Division, saw the possibilities of this tube and development work on a new camera was started by Marconi's. The research on the tube was put into the hands of Mr. G. B. Banks of the English Electric Valve Co. Ltd.

The result was the Marconi Mark III camera with its associated English Electric Valve Co. pick-up tube, which had a tremendous sale before being superseded by the Mark IV. The latter, embodying further improvements, notably in increased stability of operation and in reduced size and weight, is selling in quantity all over the world including the United States, where the high quality of its picture has been enthusiastically acclaimed. In Britain, the B.B.C. has adopted the 4½ in. image orthicon as its standard, as have several of the independent television programme contractors.

The presentation of the award was made at the Ziegfeld Theatre, New York, on 16th May. Mr. J. F. James, Chief Development Engineer of Marconi's Broadcasting Division and Mr. W. E. Turk, Manager, Photoelectric Tube Division of the English Electric Valve Co., were the recipients on behalf of their respective companies.



Photographs showing (left to right) Mr. W. E. Turk (Manager, Photoelectric Tube Division, English Electric Valve Co. Ltd.), Mr. J. F. James (Chief Development Engineer, Broadcasting Division, Marconi's Wireless Telegraph Co. Ltd.) and Mr. C. E. Burnett (Vice-President, Industrial Tube Products Division, Radio Corporation of America), after receiving the statuettes on behalf of their respective companies.

Texas Instruments Ltd.

Texas Instruments Ltd. has commenced commercial production of high-speed silicon epitaxial transistors. The first to be made available is the Type 2S131 which, compared to conventional switching transistors of the Mesa-type in equivalent circuits, will switch approximately twice as fast at the 10 mA current level and four times as fast at 100 mA.

The Type 2S131 has an extremely low typical collector capacitance of 3·5 pF at 5 V, a typical F_t of 300 Mc/s and typical switching characteristics in saturated cirsuitry are a turn-on time of 8 ns and a turn-off time of 25 ns. These characteristics, combined with the low and essentially temperature independent saturation resistance of the device make it particularly suitable for application in the current range of 1—100 mA with a maximum allowable continuous collector current rating of 200 mA.

The Texas range of large-volume transistors has been extended by the introduction of three new germanium alloy-diffused Mesa transistors which have been specially designed for operation in high frequency amplifiers and fast switching circuits. Each device type is characterized to facilitate circuit design covering the following applications:

2G401: High gain i.f. amplifier at 465 kc/s and 10 Mc/s.
2G402: V.H.F. amplifier at 100 Mc/s.
2G403: Logic and arithmetic circuits operating at clock rates of 10 Mc/s.

Economies which have resulted from the improved methods of production at Texas Instruments new plant at Manton Lane, Bedford have made possible major price decreases in the Company's entire range of semiconductor devices (diodes, rectifiers and transistors).

In certain cases there will be reductions of up to 35% and it is hoped that prices will reduce steadily in the course of the next few years.

E.M.I. Representative Gives Technical Lecture in Moscow

J. Sharpe, Esq., B.Sc., A.M.I.E.E., of E.M.I. Electronics Ltd., was chosen by the Russian authorities, as a representative of the Scientific Instrument Manufacturers' Association at the British Trade Fair, Moscow, to give a technical lecture to a Russian audience. Mr. Sharpe is the manager of the Company's special electronic valve and tube division and the subject of his paper was "Photomultipliers and their Applications".

The lecture covered such points as the design and characteristics of photomultiplier tubes, and their specialized modification for particular applications.

Mr. Sharpe recently returned from Vienna where he attended the Symposium on "The Detection and use of Tritium in the Physical and Biological Sciences". During this Symposium he was chairman of one of the sessions.

In September, E.M.I. Electronics will sponsor in London an International Symposium on "Photomultipliers", which is said to be already attracting wide interest.

Marconi Successes in International Apprentice Competition

Two apprentices employed by the Marconi Wireless Telegraph Co. Ltd. won their way into the team of sixteen chosen to represent Great Britain in this year's International Apprentice Competition. Both gained top places in their particular categories in the eliminating round. There was a record total of 420 entries for the competition.

The Marconi members of the team were Derek Saffell, who came first in the Radio Fitting section and Derek Morgan who was first in the Senior Milling category.

The 1961 competition was held at Duisburg, Western Germany, from 30th June to 16th July.

S.I.M.A. Set Up Committee for Ultrasonics

The many advances in the field of ultrasonics during the past fifteen years has caused a great number of problems. The Ultrasonics Executive Committee, has, therefore, been set up by the Scientific Instrument Manufacturers' Association of Great Britain, after joint consultation with a number of interested manufacturers to study the problems arising and to see what may be done to bring order into this field.

The need for the Committee arose after a discussion between Dawe Instruments Ltd., and Mullard Equipment Ltd. The Committee is under the Chairmanship of Mr. W. Owen-Roberts of Mullard Equipment Ltd., and members of the Committee will include representatives of Dawe Instruments Ltd., W. Bryan Savage Ltd., Kelvin & Hughes Ltd., Standard Telephones & Cables Ltd., and Smiths Industrial Division of S. Smith & Sons (England) Ltd.

The Executive Committee will organize a number of working groups to study the various aspects of the subject and representatives from other firms concerned with the ultrasonic field have been invited to participate in the work.

The first work will be a study of the terminology used in ultrasonic work. The next will be a detailed study of the measurement of acoustic power in liquids, the assessment of ultrasonic cleaning efficiency, the problems associated with the use of ultrasonics in flaw detection and measurement, those arising from the medical application of ultrasonics and those due to the increased industrial use of ultrasonics.

The Committee intends to make recommendations for action which will be passed to the appropriate national and international bodies for consideration.

Lexor Electronics Ltd.

Lexor Electronics Ltd. has removed its headquarters and production unit to much larger premises at 31 Allesley Old Road, Coventry. The resultant increased factory facilities allow considerable expansion of the Company's capacity for the production of delay lines and networks and other miniature components.

The laboratories are also expanded and remain at 25 Allesley Old Road under the guidance of Mr. J. C. Pledger, Technical Director and Chief Engineer.

Mr. H. J. Lucas, the Managing Director, continues to hold direct responsibility for manufacturing and production.

G.E.C. to Develop Missile Guidance System

The General Electric Co. Ltd. has revealed that its Applied Electronics Laboratories at Stanmore, Middlesex have been entrusted with the development of the guidance receiver for the Mark 2 Seaslug ship-to-air missile, the existence of which was made known in the recent Navy Estimates. The Mark 2 Seaslug will have a greater range and speed than the Mark 1 to deal with the types of aircraft likely to be encountered during the latter part of this decade. This Mark 2 version will be fitted in the two guided missile destroyers soon to be ordered.

The equipment forming the guidance link is carried partly in the missile and partly on board ship, the main shipborne installation being a large radar equipment: this is capable of locking-on to and following the specified target and producing a very narrow beam of radiation. The equipment contained in the missile, comprising guidance receiver and aerial system is by contrast extremely light and compact.

When a target is designated the tracking radar is locked-on to it and thereafter the beam of the radar equipment remains on the target no matter what evasive manoeuvres it makes. The missile may now be fired from its launcher, which has been trained along the axis of the radar beam, so that after launch the guidance receiver can pick up signals from the beam. The receiver contains the circuits needed to work out any positional error which the missile may have in respect to the centre of the beam and produces the correcting signals; these are fed into the control system which is determining the flight path of the missile and presenting the information so gained in the form of fin movements required to steer the missile back towards the central axis of the radar beam.

Belling-Lee Export Dinner

On Wednesday, 31st May, Belling & Lee Ltd. held their annual export dinner at the Grosvenor House, Park Lane, London. Eight different countries were represented by senior members of the firm's overseas agents; in many cases these were the heads of their respective organizations.

After the dinner, Mr. E. M. Lee reviewed the Company's recent performance in export markets, where last year "Belling-Lee" showed a 35·5% increase. He then gave a brief account of overall progress, and the firm's plans for the future.

The following countries in order of achievement were represented, Switzerland, Italy, Holland, Denmark, West Germany, New Zealand, Sweden and Belgium.

Metway Electrical Industries Ltd.

Metway Electrical Industries Ltd. are now celebrating their Silver Jubilee Year, and, with the continuing expansion of the Company since its inception in 1937, the Board of Directors considered that alterations and additions to the Board were necessary. To mark the commencement of the Silver Jubilee Year, therefore, the following appointments have been announced.

Mr. Robert F. Still, Director since 1946, now becomes Joint Managing Director with Mr. D. G. E. Barrie (founder of the Company), who remains Managing Director and Chairman.

In order that there shall be the closest co-operation between the Board and the various heads of departments, and to reward these members of the staff for their service to the Company, the following have been appointed Directors:

Mr. Stanley V. Funnell (Works); Mr. Lionel Brulais (Sales); Miss Marjorie Crock (Export); Mr. Walter T. Tompsett (Accounts).

'Transistors'—A New Film from Mullard

The latest film to be released by Mullard, deals with semiconductor research, manufacture and applications, and is intended to appeal to a wide variety of audiences, both technical and semi-technical.

The film is entitled "Transistors" and the opening sequences were made at a remotely-controlled railway marshalling yard showing the automatic control of the destination and speed of shunted wagons by a computer which directs the wagons to their correct sidings.

A simple explanation of the working of semiconductor devices follows, free use being made of animated diagrams to illustrate the functioning of both transistors and diodes.

The main body of the film deals with research and manufacturing techniques used in the development and mass-production of these devices. The production story starts with the conversion of germanium dioxide into a bar of the metal, its refinement, and the manufacture of the wafers which constitute the bases of germanium transistors. Successive production sequences for these and silicon types are closely followed showing many complex and ingenious machines used in the automation of various processes.

Examples of the rigorous test procedures applied to the devices before they leave the factory are then depicted.

Sequences taken in the research laboratories outline some of the problems undertaken by physicists and chemists working alongside mathematicians and engineers, including the investigation of the crystalline structure of semiconductor materials.

The film closes with illustrations of further applications of transistorized equipments. Among these are soil analysis by electronic means and meterological observations with airborne apparatus.

The final sequences, of a rocket launching, symbolise the fields in which transistors are playing an important part.

"Transistors" will have the widest possible distribution to engineers in the industry, government departments, educational establishments, radio and electronics societies and film societies. In addition, it should find a wide audience amongst radio and television dealers at the regular film meetings which the Company organizes throughout the country.

The film was made in Eastman Colour by Greenpark Productions Ltd. in association with the Film Producers' Guild. Script and direction was by Clive Rees, production by G. Buckland-Smith, photography by Frederick Gamage. It was edited by John Farr. Special music was written by Don Banks and conducted by Marcus Dods. Sound recording was by Ron Abbott.

The total running time of the film is 25 minutes, and it is available for distribution in 16 mm. copies.

G.E.C. Increases Output with E.M.I.-Grimston Table

An electronically-controlled drilling machine equipped with a multi-spindle head, has enabled a female operator at the General Electric Company's Telephone Works at Coventry to quadruple her output. The machine has paid for itself by the saving of tooling costs on its first job. For future jobs, the only extras will be the negligible cost of new tapes, and in all cases design modifications can be made much more cheaply than when using conventional drilling methods. Altering a jig can take up to ten hours but a new tape can be made in fifteen minutes.

G.E.C.'s problem was to make varying numbers of holes in small batches of printed-circuit boards of several different designs. An E.M.I.-Grimston positioning table, supplied by E.M.I. Electronics Ltd., was equipped with a seven-spindle drilling machine designed and constructed by G.E.C.'s Works Technical Services Department. The drill is also controlled by the E.M.I. system. The positioning equipment uses a measuring element with an electrical accuracy of ±0·0005 in., which gives a guaranteed positional accuracy of the table of ±0·002 in. with repeatability to ±0·001 in. Information can be fed into the system by punched tape or set up on dials.

A removable baseboard is loaded with seven packs, each of five printed-circuit boards, located by datum holes on pins, and then fixed to the table. The x ordinate is read and the table moves in the x direction and is locked. The y ordinate is then read and the table moves in the y direction and is locked. The spindle feed is actuated and drilling takes place. The cycle is repeated for the second hole. The reading of the x ordinate starts while the spindles are retracting.

Duplicate baseboards facilitate unloading and reloading of one while the other is on the machine, thus ensuring maximum machine utilization.

Female operators prefer using the E.M.I. system as it imposes less physical and mental strain than conventional drilling methods, which always carry the risk that a girl may accidentally overlook drilling one or more holes. Such an oversight would not be noticed until the printed-circuit boards reached the inspection department, causing considerable delay while the boards were returned to the machine room for further holes to be drilled.

The Plessey Co. Ltd. and Regentone Products

The Plessey Co. Ltd. has acquired the Eastern Avenue, Romford factory of Regentone Products Limited for £507,000. Plessey has also entered into an agreement with Regentone whereby Regentone and R.G.D. television and radio models will be manufactured by Plessey to Regentone specifications. These sets will continue to be marketed by Regentone.

Plessey will use the factory for the extension of its activities in the Ilford area and will offer alternative work to the bulk of the people previously employed there.

Australian Agency for Beulah Electronics

Watson Victor Ltd., 9-13 Bligh Street, Sydney, Australia, a Company long established in the scientific and industrial electronic field, has been appointed Sole Agent for the "Beulah Electronic" range of closed-circuit television equipment.

Watson Victor Ltd. has placed orders for a quantity of D800 television cameras, to enable them to demonstrate in their showrooms in Brisbane, Sydney, Melbourne, Adelaide and Perth.

Magnavox Stereo Demonstrations

The Music Festivals, inaugurated in February by Magnavox Electronics Ltd. to demonstrate their stereo equipment to the public, have proved so successful that they will remain a permanent feature of Magnavox promotional facilities available to accredited dealers.

In three months the Music Festivals have visited 17 towns in England, and audiences have totalled about 6,700 people.

Bookings by dealers for the Music Festival extend up to November and places to be visited soon are Blackburn and Rishton, Lancashire; Northwich and Macclesfield, Cheshire; Birmingham (three festivals arranged), Staffordshire, and Woking (Surrey).

The Magnavox Music Festival is a 1½-hour demonstration of high-fidelity stereophony using three Magnavox stereograms (the ST.207 "Concert Hall",S G.400 "Serenade" and SG.420 "Symphony") and the "Melody" stereo record player. With the exception of two Magnavox recordings, all the stereo discs played are from stock, and the programme includes music to suit all tastes.

BICC and Bessbrook Products Ltd.

British Insulated Callender's Cables Ltd. recently acquired the share capital of Bessbrook Products Ltd. of Newry, County Down, Northern Ireland.

Bessbrook Products Ltd. were established in 1957 as manufacturers of enamelled wire; BICC intend to continue the present operations of the Company and to make available to it the techniques and manufacturing information resulting from their own long experience in the design and production of this type of wire.

All staff and work-people of Bessbrook Products Ltd. have been told that their conditions of employment remain unaltered as a result of the entry of Bessbrook into the BICC Group.

British Space Development Company Appoints Adviser

Professor Sir Bernard Lovell, O.B.E., F.R.S., Professor of Radio Astronomy at the University of Manchester and Director of the Nuffield Radio Astronomy Laboratories, Jodrell Bank, has accepted the appointment of Scientific Adviser to British Space Development Company.

Professor Lovell's work at Jodrell Bank has so far been this country's best-known contribution to international space research. His services as Scientific Adviser to the British Space Development Company will be of great value to the Company's technical committee which is engaged in detailed investigations into ways and means of launching a British space programme for communication satellites in the near future.

New Colour Television Display System

Scientists of the Mullard Research Laboratories presented a series of papers on a novel colour television display system at a meeting of the Electronics and Communication Section of The Institution of Electrical Engineers on the 15th May. The display system has been given the code name "Banana" because of the shape of the cathode-ray tube.

The inventor of the system, Dr. P. Schagen, set out some years ago to overcome the major disadvantages of present display devices. Some success has been achieved, but the system has fundamental drawbacks of its own.

Publication of the work, while the natural accompaniment of any scientific investigation, was particularly aimed to get the reactions of scientists and manufacturers to the new concepts involved in the system.

The main advantages of the system are in the relatively cheap and simple cathode-ray tube, the high picture contrast, and the shallow cabinet. Its disadvantages are a narrow viewing angle and the incorporation of optical and moving parts.

The authors, Mr. B. Eastwell, Mr. K. G. Freeman, Mr. A. Howden, Mr. R. N. Jackson, Mr. B. R. Overton and Dr. P. Schagen, represented a team working in the Mullard Research Laboratories under the Director, Mr. P. E. Trier.

The authors emphasised in their papers that the system in the form that was demonstrated is not a practical proposition for a domestic receiver.

New Representatives for Hilger & Watts

In order to augment their outside staff and improve the contact between themselves and their many friends and customers in two important districts—Scotland and the Midlands—Hilger & Watts Ltd. has recently appointed two more representatives.

For Scotland, they have appointed Mr. Alastair Campbell, B.Sc., whose base will be the offices of Elesco Electronics Ltd., 2 Fitzroy Place, Glasgow, C.3; *Tel. Glasgow Central* 1082. Mr. Campbell, until recently a plastics engineer and technologist, is well versed in the needs of industrial analysis.

For the Midlands, E. R. Sayer, B.Sc., Ph.D., has been appointed. His address is 32 Mountford Crescent, Aldridge, Nr. Walsall, Staffordshire; *Tel. Aldridge* 53151. Dr. Sayer has been a specialist in infra-red spectrophotometry and has a particular interest in applications of infra-red and ultra-violet spectrophotometry to analytical problems. His area will include Staffordshire, Derbyshire, Nottinghamshire, Warwickshire, Leicestershire, Northamptonshire, Gloucestershire, Herefordshire, all Wales apart from Flintshire, and the towns of Banbury in Oxfordshire and Crewe in Cheshire.

Mr. Campbell and Dr. Sayer will both pay periodical visits to customers in their districts, to learn of needs and give advice on problems, and both will always be pleased to hear from people who need the help that Hilger & Watts can give them in the field of optical instruments for analysis, engineering metrology, and surveying.

They join Mr. D. G. Heywood, A.Met., who for a few years has represented Hilger & Watts in the North of England, his address being 21 Kirkstall Road, Sheffield 11; *Tel. Sheffield* 64226.

French & American Investment in Israel Electronics

A new electronics company, headed by the former French Ambassador to Israel, is reported from Jerusalem by Barclays Bank D.C.O. to have been formed by French, American and Israeli investors. It is to design, develop and manufacture electronic equipment, to produce radios under a French licence and to act as the sales representative for leading American and French firms.

Formica Industrial Laminates Colour Film

'Inside', the first colour film to be produced by the new De La Rue Film Unit was taken at the Tynemouth factory of Formica Ltd. and features the product, its manufacturing processes and the people who work there. A notable point which emerges very clearly from the film is the rigid quality control which is operated at every stage during the manufacture of Formica laminated plastic, and it is this quality control which enables Formica industrial material to be adapted and made to measure for widely divergent applications in many branches of electronics and engineering.

This 16 mm. film with optical sound runs for approximately 20 minutes and is designed for trade and technical audiences in the plastics, electrical and allied industries and also for students at technical colleges and at Universities.

Copies of the film are available on free loan from the Formica Public Relations Department, 84/86 Regent Street, London, W.1, or through Formica (Industrial) Area Officers.

Raytheon Establish Transistor Factory in India

Establishment of the first transistor manufacturing company in India has been announced by the Raytheon Company, in conjunction with Indian business interests.

The new company, Semiconductors Private Ltd., in which Raytheon owns a one-third interest, is located in Poona, India. The facility, now under construction, is planned to produce transistors and diodes by the end of 1961.

The only company licensed by the Indian government to make and sell these products in India, Semiconductors Private Ltd. also plans to supply competitively-priced semiconductors to major world markets.

Raytheon holds options to increase its investment in the new firm, subject to the approval of the Indian government. Participants with Raytheon are Indersen T. Mirchandani and Taru J. Lalvani, prominent Indian businessmen. Both are directors of the new firm. Mr. Andrew P. Young, Raytheon's director of International Sales and Services, will represent Raytheon on the board of directors.

West Country Ambulances Equipped with Pye Radiotelephones

Pye Telecommunications Ltd. of Cambridge has been awarded the contract for the supply of radiotelephone equipment for Devon County Ambulances. The installation will be carried out in four stages, the first part consisting of one fixed station, remote controlled, and 15 mobile units. On completion the scheme will comprise four fixed stations and approximately 60 mobile equipments.

It is anticipated that ambulances in the Torbay area will be equipped with radiotelephones before the start of the main holiday season. With the inclusion of the radiotelephone equipments now being supplied to the Monmouth County Council all ambulances in South-West England and South Wales will be equipped with Pye radiotelephone units.

Pye Telecommunications Ltd. has now equipped the ambulances of over 100 County Boroughs and County Councils in England and Wales with radio communications equipment.

E.R.A. Divisional Committee No. 2—Power Plant

The Electrical Research Association announces the composition of Divisional Committee No. 2—Power Plant, which held its first meeting on the 4th May, 1961:

Mr. E. S. Booth, Chairman (*Central Electricity Generating Board*); Dr. A. T. Bowden (*C. A. Parsons & Co. Ltd.*); Mr. J. Caldwell (*The English Electric Co. Ltd.*); Mr. W. W. Campbell (*Merz & McLellan*); Dr. W. H. Darlington (*Associated Electrical Industries Ltd.*); Mr. F. Dransfield (*Central Electricity Generating Board*); Mr. M. G. Gemmill (*Central Electricity Generating Board*); Mr. J. B. Jackson (*Central Electricity Generating Board*); Mr. E. Hywel Jones (*South of Scotland Electricity Board*); Mr. K. J. McKillop (*Water-Tube Boilermakers' Association*); Mr. J. Mayer (*International Combustion Ltd.*); Mr. J. M. Mitchell (*The General Electric Co. Ltd.*); Mr. C. W. Priest (*Central Electricity Generating Board*); Mr. W. F. C. Schaap (*Babcock & Wilcox Ltd.*).

Dr. H. G. Taylor, Director of the Electrical Research Association, is an *ex officio* member of the Committee, and the Secretary is Mr. G. A. W. Taylor of the Electrical Research Association.

E.M.I. Community Television at Bedford

The Community Television System, supplied and installed by E.M.I. Electronics Ltd. and Multisignals Ltd., was officially inaugurated recently by Alderman A. H. Randall, J.P., Mayor of Bedford, in the Community Hall.

E.M.I.'s aerial array, fitted 379 ft. above sea level to the top of Ravensden Water Tower, four miles north-east of the town, covers Bands I, II and III. It provides B.B.C. TV, London I.T.V. and Anglia I.T.V. programmes, B.B.C. v.h.f. Home, Light and Third sound programmes and Radio Luxembourg, which is picked up direct and redistributed on the v.h.f. waveband. Signals provided are thirty to sixty times stronger than those obtained from a conventional aerial.

During the official opening day members of the public were invited to view comparative television pictures of the same programme on receivers served by the E.M.I. system and by a conventional aerial, between 1.30 p.m. and 10 p.m. An innovation was the provision of comparative pictures of the experimental colour television programme radiated by the B.B.C. between 4 p.m. and 4.30 p.m.

This is the largest community television system to be provided by Multisignal Ltd. so far, and the Company's first wide band system. The service became immediately available to 4,000 of Bedford's 19,000 houses. It will be available to 10,000 houses by the end of 1961, and subsequently the service area will be continually extended. As the supply and erection of a conventional television aerial in Bedford can cost up to £35 and the resulting television pictures leave so much to be desired, it is anticipated that there will be a brisk demand for the new service.

Use of the wide band technique means that thirteen television channels will be available to subscribers. After allowing for the three television programmes at present being radiated in the area, ample provision remains for any new programme which may be started in the future, as well as such additional facilities as 625-line standard, coin-in-the-slot operation and colour television. This is an important point in a town so near to London, which can reasonably be expected to be the first area to benefit from such new developments.

The whole of the cable run from the water tower to the town is buried underground. This has enabled the installation to be completed more quickly than would have been possible if an overground pole run had been used.

A big advantage of the E.M.I. system is that any preferred brand of television receiver can be used, and the subscriber is not restricted to one particular type of set, as is the case with many other piped television systems.

E.M.I. Community Television Systems are already operating successfully at Grimsby, Boston, Wantage and Cwmbran—a South Wales satellite town. Systems in several other towns will start to operate in the near future.

Original Decca Marine Radar at Olympia

The array of modern marine radar displays shown by Decca Radar Ltd. at the engineering, Marine, Welding and Nuclear Energy Exhibition at Olympia this year was all the more dramatic for the presence, adjacent to their latest true motion 16-in. display, of the very first Decca marine radar installed in any ship, the Type 159. This unit was removed from s.s. *Birdwood* after some 11½ years service. It was after successful trials with this particular radar at the end of 1949 that Wm. France, Fenwick & Co. Ltd. specified the Decca 159 for 22 coasters, the first fleet order ever received by Decca Radar Ltd.

Comparison between the 159 display unit and the latest 16-in. true motion console from the Decca D 11 series shows, at one glance, the tremendous advance in marine radar presentation techniques which has taken place in the last ten years, an advance in which Decca have been pioneers in every important respect, particularly true motion and the recently introduced interscan technique for range and bearing measurement.

The first true motion radar in the world was introduced by Decca in 1956. The present TM 969 is the third in the series of Decca true motion radars, of which over 800 are at sea. The total number of ships for which Decca radar has now been ordered exceeds 10,500.

Fairchild Flight Analyzer Demonstrated at English Airfield

The first overseas demonstration of the photographic flight analyzer, available from the Industrial Products Division of the Fairchild Camera and Instrument Corporation, was held early last May at Cranfield Aerodrome. Aveley Electric Ltd., is representing Fairchild for the photographic flight analyzer in England.

Many aviation industry people and military authorities attended the demonstration during which the flight analyzer tracked the landings and take-offs of two aircraft. The photographic results of the flights were available for review by the persons attending the demonstration during the latter half of the demonstration.

The photographic flight analyzer is a precision tracing device operated manually by one person which will accurately record the space trajectory of a moving object on film. Its advantages include the ability to track moving objects at high azimuth rates, a low cost for reducing the data obtained from the tests, and portable equipment which does not sacrifice accuracy.

The demonstration was run by Mr. Lee Schank of Fairchild's engineering staff. Also attending from Fairchild were Mr. Ernest Marx, Manager of Fairchild International Division, and Mr. James Segre, European Regional Manager for the firm.

Marconi's High-power Short-wave Transmitters for B.B.C.

A further contract for two 100 kW twin-channel high-frequency sound broadcasting transmitters, valued at approximately £160,000, has been placed with Marconi's Wireless Telegraph Co. Ltd. by the British Broadcasting Corporation.

These equipments are a departure from conventional design in that the penultimate and final r.f. amplifier valves and those of the modulator are vapour-cooled. The transmitters are scheduled for installation at the B.B.C. External Services station at Daventry, for which two of the same type are already on order. A further two of somewhat similar design have recently been installed at the B.B.C.'s Rampisham (Dorset) station, making a total of six in all.

Vapour-cooling is a system whereby the heat generated by the valves is transferred to water-jackets surrounding them. The resultant steam is taken by convection to a condenser which converts it once more to water for return by gravity feed to the water-jackets.

The ability to effect a speedy changeover from one frequency to another is a highly desirable feature for high-frequency broadcasting services, and this aspect has received especial attention in the design of the new equipments by the provision of two r.f. amplifiers per transmitter. These are contained in separate cubicles on either side of a common modulator, which is switchable to either. With the r.f. amplifiers set up on alternative frequencies a changeover can be made virtually instantaneously by switching the modulator output to the standby amplifier.

The vapour-cooled valves used are manufactured by the English Electric Valve Co. Ltd.

Decca Computer Tape Testing Service

Decca Radar Ltd. has recently established a computer tape service at their Hersham laboratories where tapes undergo a series of rigorous tests prior to being graded and supplied to computer users.

All tapes subject to these tests must comply with strict mechanical and electrical acceptance specifications; they are then graded according to their rejected regions, that is, areas of confirmed drop-out or drop-in which are shown to occur at the same positions on the tape during repeated play-back. Tapes which are completely free of rejected regions are classified as Grade 1; Grade 2 tapes may contain limited rejected regions.

The surface finish of magnetic tapes is dependent upon the base smoothness and oxide bonding agent; loose oxide particles on the tape surface, and irregularities such as pin holes, lumps of oxide and impurities are detected by the tape testing service in the early stages.

After completion of the tests each tape is coded according to its magnetic and mechanical specification and identified by a serial number printed on the backing side of the tape leader. It is then wound on a spool and packed in a dust proof polythene bag, finally being stored in either a metal or cardboard container ready for shipment.

Canadian Agency for Aveley Electric

Aveley Electric Ltd. has been appointed sole United Kingdom agent for the Bach-Simpson range of top-quality measuring, testing and control instruments. The Bach-Simpson Co. is a completely autonomous Canadian Company of high repute, producing the Simpson Line of instruments in Canada entirely from its own resources, but sharing with the Simpson Electric Co. (Chicago) joint engineering and mutually advantageous development projects. The Bach-Simpson merchandising interests lie exclusively within Canada and the British Commonwealth.

The range of instruments which will be available to the British market will include multi-range test equipment, panel mounted control indicators, frequency and running time meters, components, educational instruments, radio and television service equipment, laboratory apparatus, oscilloscopes and a wide range of portable instruments.

Aveley Electric Ltd. will immediately introduce the Simpson Type 260 and 270 test meters and the Bach-Simpson control indicator. Other instruments will be introduced at intervals.

Audiences assembled in both places to hear the conversation over loudspeakers. The U.S. panel used a three-pickup system employing Shure's newest 545 Unidyne III dynamic microphones in desk stands. The trans-atlantic conversation was recorded on an Ampex 351-2 stereo tape recorder.

Topics ranged broadly over the entire audio field, including transitorized power supplies and amplifiers, ribbon *versus* dynamic microphone, proper output and placement of speakers at public events, theatre sound systems and stereo pick-up of musical presentations.

On both sides of the Atlantic, participating engineers pronounced the experiment an unqualified success. Sound fidelity was of the highest quality, with good frequency response and complete freedom from fading.

New Application for English Electric Vidicons

The Annual Kelvin Lecture at the Institution of Electrical Engineers was given by Professor R. F. Woolmer of the Royal College of Surgeons. During his discourse on the subject "Medical Electronics" extensive use was made of closed-circuit television provided by the English Electric Valve Co. Ltd.

The lecture included various demonstrations showing displays on cathode-ray oscilloscopes. By means of a Marconi industrial vidicon television camera channel and several monitors suitably placed in the auditorium, these waveforms were made clearly visible to the audience.

The use of a special "long lag time" version of the recently announced vidicon, Type 7038, together with suitable lens filters, allowed the presentation of sharp traces.

English Electric Valve Co's. Colour Film

A colour film has been produced by the English Electric Valve Co. Ltd., so that agents and friends at home and overseas, who under normal circumstances would be unable to make a personal visit, may have the opportunity of seeing the Company through the medium of film.

The film "By Precision to Perfection" commences with various applications of the Company's products and then shows how components for all product divisions are manufactured in the machine shop. The film continues with the production, assembly and test of a magnetron and in this sequence the intricate work of magnetron manufacture is graphically illustrated by the photography and emphasized by the commentary. The production of klystrons, large and small valves and television camera pick-up tubes are also known in considerable detail. The dust free environment necessary for camera tubes, and the precautions taken to ensure this in the specially designed building in which these tubes are manufactured, are highlighted in this sequence.

The recreational and social facilities available to the personnel are shown to give a balanced picture of conditions in the Company.

Dramatic emphasis is added by the use of colour and the commentary describes and explains the action of the film through the technical sequences.

Educational authorities, engineering associations and other interested bodies may borrow a copy of the film free of charge from the G.B. Film Library, 1 Aintree Road, Perivale, Greenford, Middlesex. Telephone: Perivale 6666. The film runs for approximately twenty-five minutes and is made on 16 mm film.

Rivlin Instruments Ltd. Factory Extension

In order to reduce delivery times, to provide greater capacity and to improve laboratory facilities Rivlin Instruments Ltd. have trebled the area of their factory, at the Yorktown Industrial Estate, Camberley, Surrey.

New machines and additional operatives have been installed to boost the present production programme, and it is significant that Rivlin have been able to maintain production during the transition period.

Rivlin specialize in the manufacture of precision resistors which include a standard range with values of 0·1 Ω to 3 MΩ, ratings up to 3 W and working voltages of up to 2,000 V. The Company also manufactures plug-in and printed-circuit resistors as well as many special types to customers' order. Normal accuracies are ±1%, ±0·5% ±0·1%, ±0·05% and ±0·02% but higher accuracy can be provided to special order.

Coincident with the factory extension Rivlin Instruments have recently developed and introduced a new method of encapsulation, based on epoxy resin which, it is claimed, has the following advantages: wide temperature range with proof against high humidity, suitable for use in the temperature range of −55°C to +120°C with or without humidity, and without significant effect on accuracy and stability. The new range is completely interchangeable with the existing RIL types (1—9) and all dimensions are exact and repeatable within very close limits.

In accordance with the best of modern practice all terminations are gold plated to prevent oxidation during storage and to facilitate soldering without irksome preparation.

Plessey—Mallory Capacitor Agreement

The Plessey Company Ltd. announces that following an agreement with P. R. Mallory and Company Inc. it is now manufacturing a range of solid electrolyte tantalum capacitors.

Chief features of the new capacitors are stability of capacitance with temperature, and the ability to operate at extremely low temperatures down to −80° C without loss of performance. The range of capacitance values available is 0·33 to 330 μF at d.c. working voltages of 35 V—6 V.

Capacitance values up to 68 μF are available in a choice of working voltages up to a maximum of 35 V d.c.

These new capacitors supplement the established range of Plessey "Castanet" liquid electrolyte tantalum capacitors.

PERSONALITIES

Mr. M. A. Griffith-Jones

Mr. Morley A. Griffith-Jones, O.B.E., has been appointed General Sales Manager of Chloride Batteries Ltd. He will be responsible for sales of all the Company's products in the United Kingdom and overseas including Exide automotive and aircraft batteries, chloride stationary batteries and Keepalite emergency lighting equipment, Exide-Ironclad traction batteries and Exide dry batteries.

Mr. Griffith-Jones was educated at Haileybury and subsequently spent some months in France. In 1936 he joined the Gas Light & Coke Company as an administrative staff pupil and received a thorough training in all aspects of the company's work.

During the war he served on the British Military Mission in the Middle East and was later attached as a lieutenant-colonel to the Polish Corps of the Eighth Army, with whom he saw fighting on the Italian Front, including the attack on Monte Cassino. He was awarded the O.B.E. in 1944.

After leaving the army he rejoined his old company and shortly afterwards, when it was nationalized and renamed the North Thames Gas Board, he became Sales Manager to three of the Board's territorial divisions. During this time he read law and was called as a barrister by Grays Inn in 1950.

In 1954 he joined the Burco-Dean group of companies as Sales Director and was responsible for the marketing of a variety of washing machines and domestic home laundry appliances.

Mr. Griffith-Jones joined Chloride Batteries Ltd. in December 1959 and took over as General Sales Manager on 2nd January, 1961, when the Sales Headquarters moved from London to the manufacturing centre of the Company at Clifton Junction.

Mr. A. W. Baker

Mr. Alan W. Baker has been appointed General Manager of Chloride Batteries Ltd. from 3rd April, 1961, in place of Mr. C. Pritchett in order to release him for other duties in technical management within the Chloride Group.

Mr. Baker was born in New Zealand and after twelve years in that country and in Australia came to England where he was educated at Eastbourne College and Peterhouse, Cambridge. He graduated with honours in the Mechanical Sciences Tripos, and subsequently spent three years with Metropolitan-Vickers Electrical Co. Ltd., first as a "College" apprentice and subsequently as a motor engineer, in which period he gained an insight into many aspects of that Company's extensive engineering interests.

After a similar period with the Manchester Corporation Transport Department, he joined the staff of Urwick, Orr & Partners Ltd., management consultants, in 1940. During the war years his assignments lay chiefly with factories producing war materials for the Armed Forces and medical supplies, and were directed to devising methods of overcoming the shortage of skilled labour and materials, as well as of increasing production. In 1952/3 he was a member of an International Labour Office productivity mission, which went to India to demonstrate to the Central Government the value of Indian industry of modern production methods as used in Western countries.

After returning to Urwick, Orr & Partners Ltd. he assisted in the building up of that Company's overseas consulting practice, finally assuming control of all their overseas activities.

Mr. Baker joined Chloride Batteries Ltd. as Assistant General Manager in November 1959.

Mr. A. W. Thomson

British Insulated Callender's Cables Ltd. has appointed Mr. A. W. Thomson, A.M.I.E.E., as Technical Manager of BICC-Burndy Ltd. Mr. Thomson, whose appointment is already effective, includes amongst his duties the design, development and application engineering of all BICC-Burndy products.

After attending Rutherford Technical College, Newcastle upon Tyne, and serving an apprenticeship with the Tyne Improvement Commission, he joined the Southern Electricity Board, and later served with the South of Scotland Electricity Board. He also held an appointment with the Air Ministry, serving in London and Aden.

Mr. Thomson joined the Accessories Division of British Insulated Callender's Cables Ltd. in 1959 as a Design Engineer, and was promoted to Senior Design Engineer a year later.

Mr. R. H. Wilson

Mr. R. H. Wilson was appointed to the Board of Directors of CIBA (A.R.L.) Ltd. on 3rd May. Mr. Wilson, who joined the Company (then known as Aero Research Ltd.) in 1954, was initially associated with the development of "Araldite" epoxy resins and was appointed General Sales Manager last year.

Mr. N. McFarlane

Solartron Laboratory Instruments Ltd. has appointed Mr. Norrie McFarlane as Regional Manager covering Scotland and Ireland.

He joined Solartron as a Senior Technical Sales Engineer in 1959, having spent several years with Ferranti, Edinburgh, as an Experimental Engineer on Radar and Navigational Aids.

Mr. D. C. Jardine

British Insulated Callender's Cables Ltd. announce that Mr. D. C. Jardine has been appointed Senior Sales Engineer for telecommunications products, operating within the BICC Home Sales Organization from 21 Bloomsbury Street, London, W.C.1.

Mr. Jardine joined the former British Insulated Company in April, 1929, and after war service as a wireless telegraphy officer in the Royal Naval Volunteer Wireless Reserve returned to BICC as a sales engineer for telecommunication cables.

Dr. E. Eastwood

Dr. E. Eastwood, Ph.D., M.Sc., M.I.E.E., Director of Research at the Marconi Research and Development Laboratories at Great Baddow, has been awarded the Wakefield Gold Medal by the Royal Aeronautical Society. The award is in recognition of his contributions towards safety in the air by the development of air traffic control and navigational aids.

The medal will be presented to him on the occasion of this year's Wilbur Wright Memorial Lecture on 12th September.

Mr. T. Blyth

Mr. T. Blyth has joined Aircraft-Marine Products (G.B.) Ltd. as General Sales Manager. He recently resigned from S. N. Bridges & Co. Ltd. to take up this new appointment.

As Bridges' General Sales Manager, Mr. Blyth had overall responsibility for domestic appliances and electric tools. He had been with the Company for nine years, moving to the main Battersea factory in 1958, after three years as Midlands Sales Manager.

After war and post-war service as an officer in the Royal Fusiliers and the Royal West African Frontier Force, Tom Blyth joined Chloride Batteries Ltd. and was later with E. R. Howard Ltd., pioneering the introduction of silicone products in this country.

In his new appointment, Mr. Blyth is responsible for sales policy of the British subsidiary company of AMP Incorporated of Harrisburg, Pa., U.S.A. The Company had many plants in America and factories in several parts of the world. The British factory is at Port Glasgow.

Appointments at Marconi's

The following appointments are announced by Marconi's Wireless Telegraph Co. Ltd.:

Mr. F. S. Mockford relinquishes his appointment as Commercial Manager in order to undertake special duties for the Managing Director; **Mr. F. Wheeler** is appointed Commercial Manager and **Mr. H. Baker** is appointed deputy Commercial Manager.

Mr. F. S. Mockford joined Marconi's as an engineer in 1930 and subsequently held a number of posts including those of deputy General Manager, personal assistant to the Chairman and Managing Director, and Sales and Contracts Manager. He was appointed Commercial Manager in 1947.

Mr. F. Wheeler was Sales and Contracts Manager, Marconi's Aeronautical Division, until his appointment as deputy Manager of the Division in January this year. Mr. H. Baker served the Company abroad for many years, latterly as Managing Director of the Marconi Company in South Africa.

MANUFACTURERS' PUBLICATIONS

Araldite

The February issue of Technical Notes 218 published by the Technical Services Department of CIBA (A.R.L.) Ltd., is devoted to the use of Araldite as an aid to archaeology.

REC 142 *for further details.*

EMI Electronics Post

The Spring issue of *EMI Electronics Post*, now available, is published by EMI Electronics Ltd.; this illustrated edition includes details of an EMI-controlled machine tool which foresees any irregularities in a tape and stops before an error can be made; a television camera tube which is sensitive to infra-red light and an interesting article entitled "New openings in closed-circuit television". Also featured are several EMIDEC computers recently installed in large industrial organizations and activities both at home and abroad.

REC 143 *for further details.*

Wires

The equipment wires described in this catalogue are manufactured by Standard Telephones & Cables Ltd. The range covered deals with p.v.c., polythene and p.t.f.e. insulated wires together with additional insulated wires which are extensively used for the wiring of radio, telecommunication, electronic and associated equipment.

There are also two appendices—"A" details the colours, electrical characteristics and joint service catalogue numbers of DEF 12-B type equipment wires and "B" lists the joint services catalogue numbers in numerical order.

REC 144 *for further details.*

A Low Voltage Power Supply

The latest pamphlet in the series *Demonstrations and Experiments in Electronics*, published by the Mullard Educational Service, describes a simple low-voltage power supply which will be useful to schools conducting experiments with transistor circuits.

The circuit is essentially a simple half-wave rectifier driven from the secondary of a mains transformer delivering 30 V r.m.s. The rectified output is applied to a variable filter network which enables a range of currents from 1 mA to 1·4 A at an output of 10 V to be obtained. Currents of up to 1·9 A can be drawn at lower output volts.

REC 145 *for further details.*

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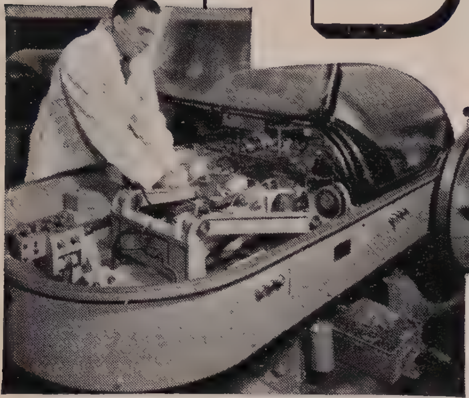

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Brandauer also specialises in precision pressings manufactured from all ferrous and non-ferrous materials including the cupro-nickel alloys.

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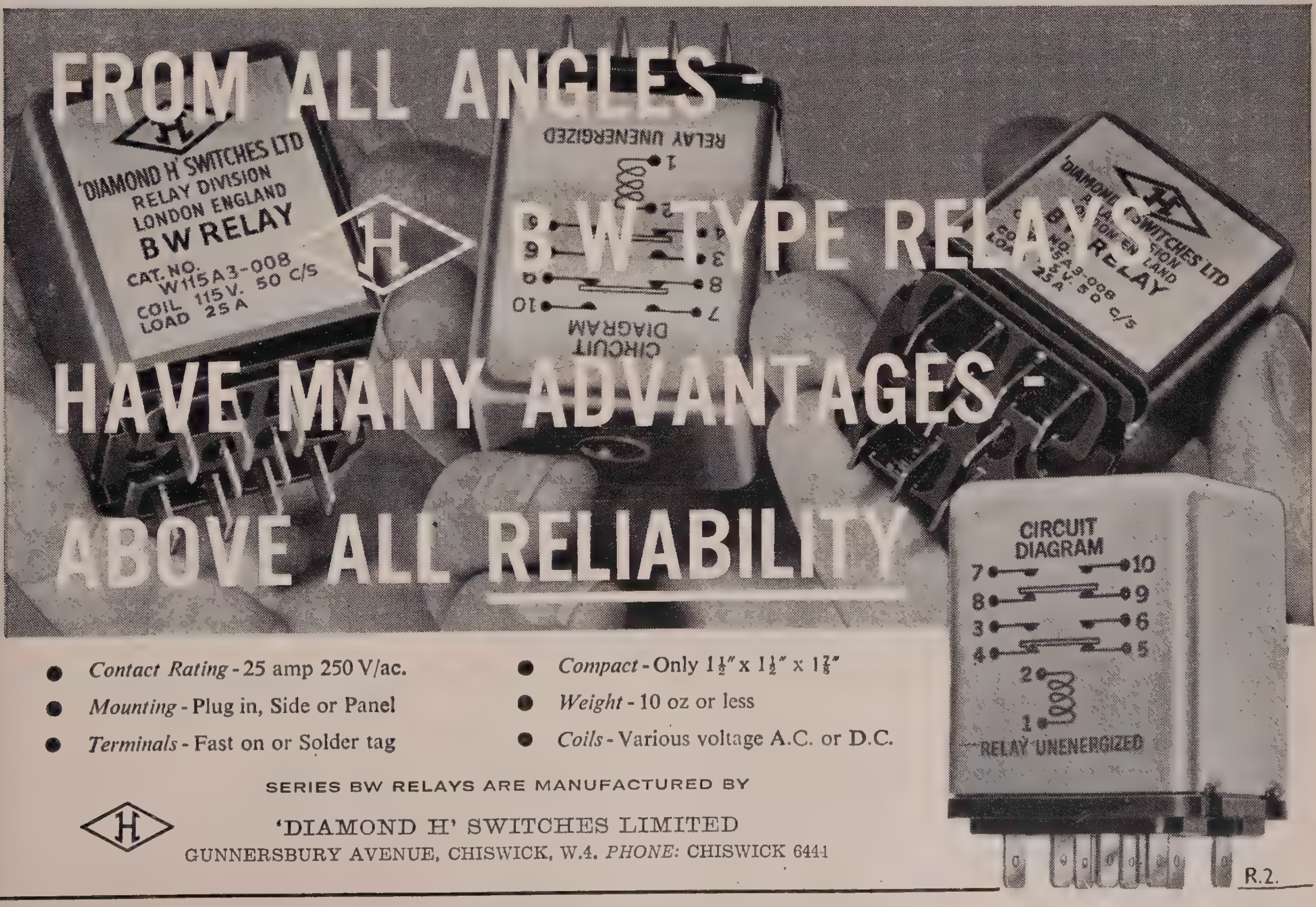

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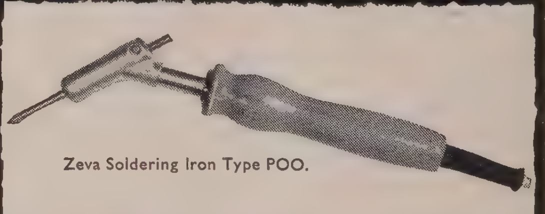
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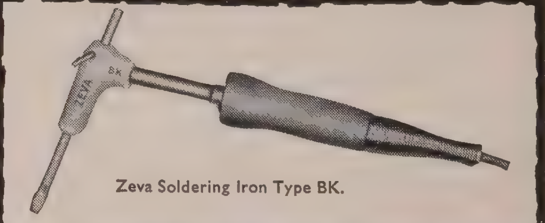

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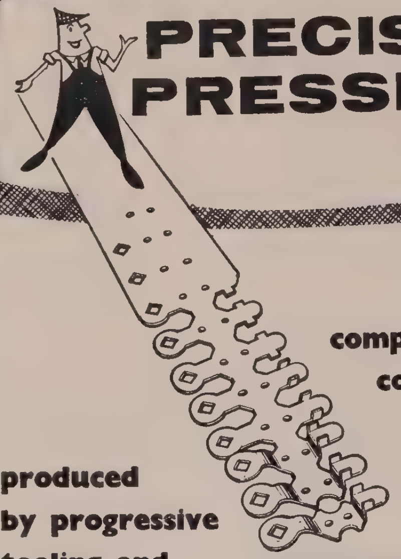

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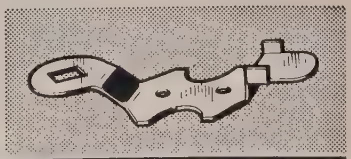

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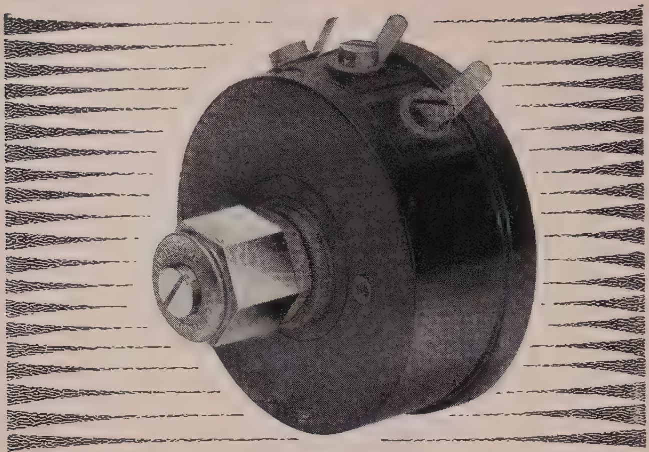

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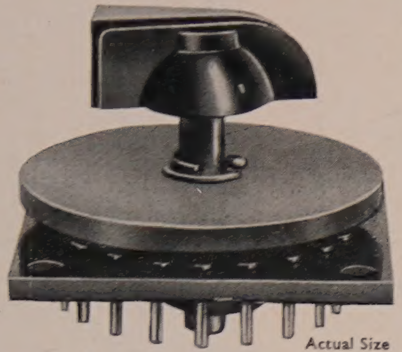

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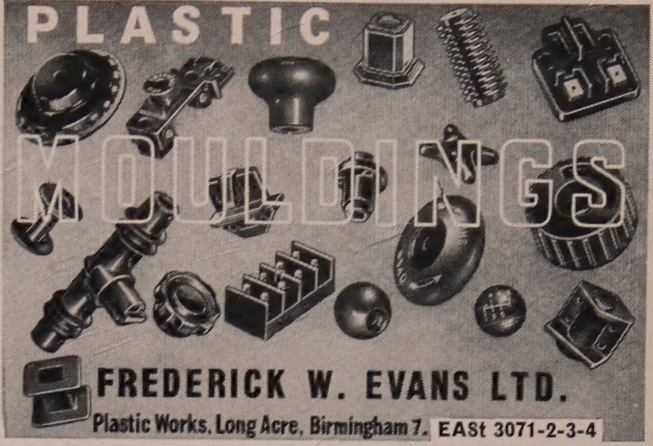

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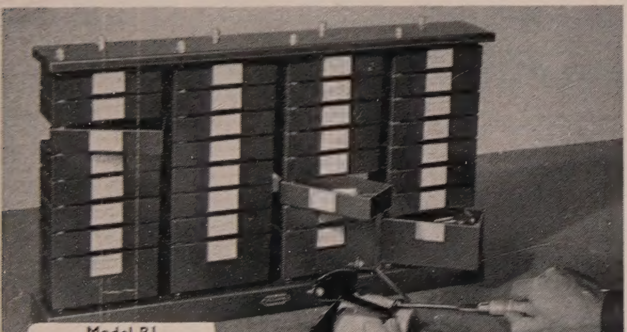

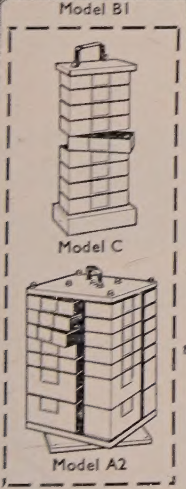

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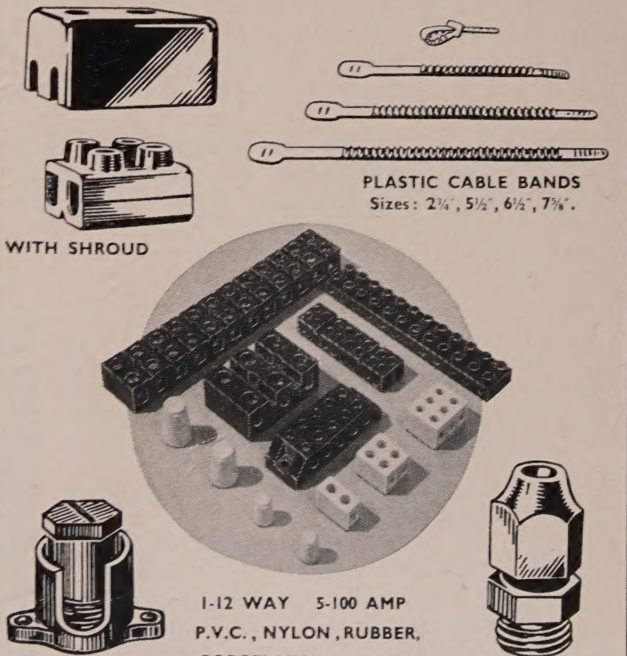

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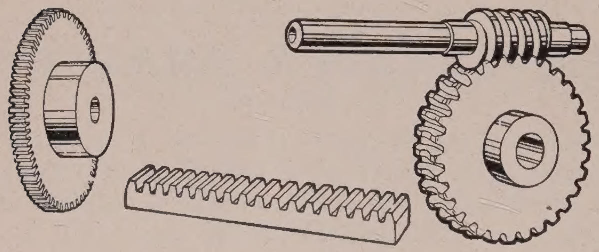

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